Second International Conference
Countermeasures to Urban Heat Isla
September 23, 2009, Berkele

National Research Project on *Kaze-no-michi* for City Planning:

– Creation of Ventilation Paths of Cool Sea Breeze in Tokyo

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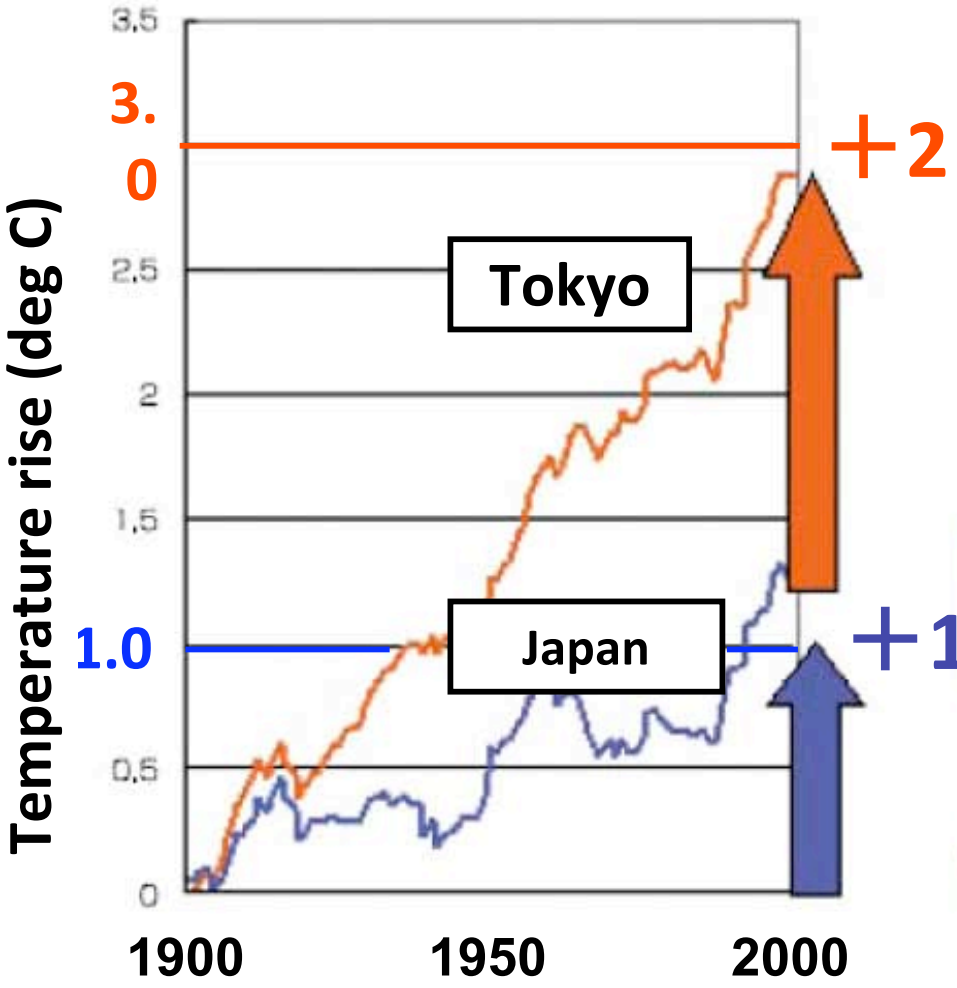
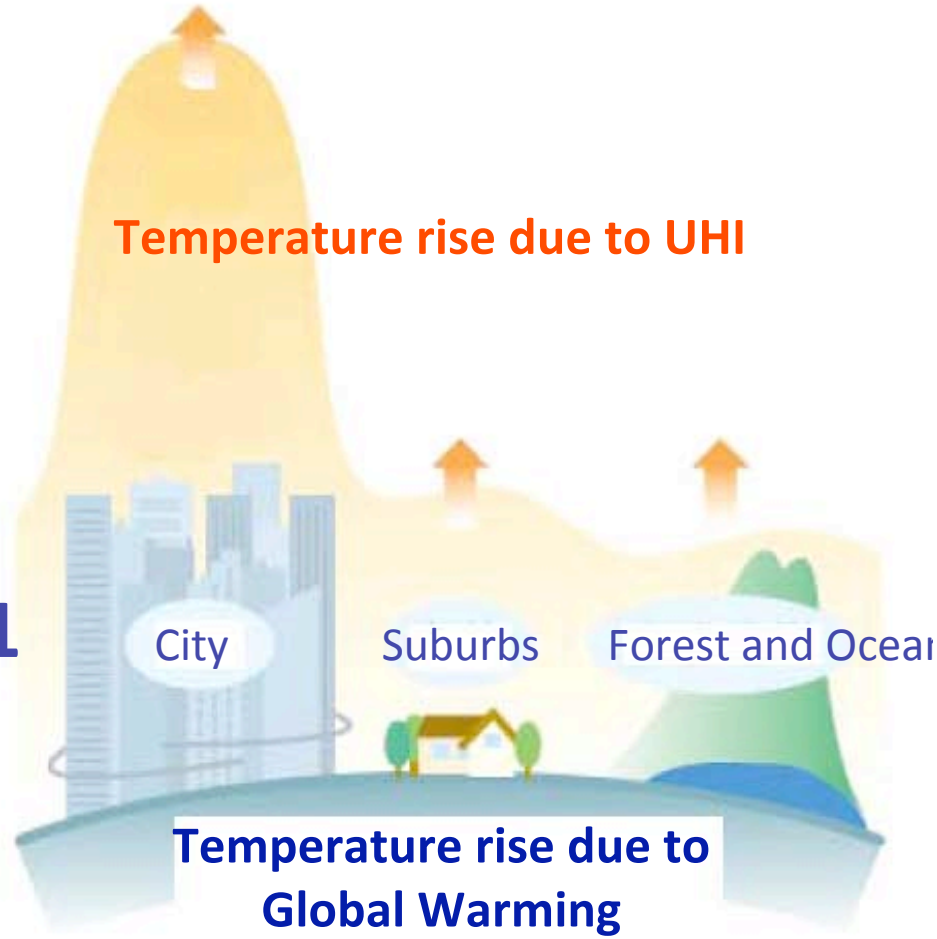
Global Warming and Urban Heat Island (UHI)





Source: Ministry of Environmen

Overview

0. Background of this project
   - What is "*Kaze-no-michi*" ?
1. Large-scale measurement Campaign
   - The effect of ***cool sea breeze*** in Tokyo
2. Case Study on Creation of "*Kaze-no-michi*"
   - Wind tunnel test using detailed urban model
3. CFD Study Using the Earth Simulator
   - Entire city in very fine resolution
4. For Applying "*Kaze-no-michi*" in City Planning
   - Classification of "*kaze-no-michi*" for urban planning
   - Development of PC software
     - In order to evaluate the effect of UHI measures

What is *Kaze-no-michi?*

kaze - no michi

||

Wind's

||

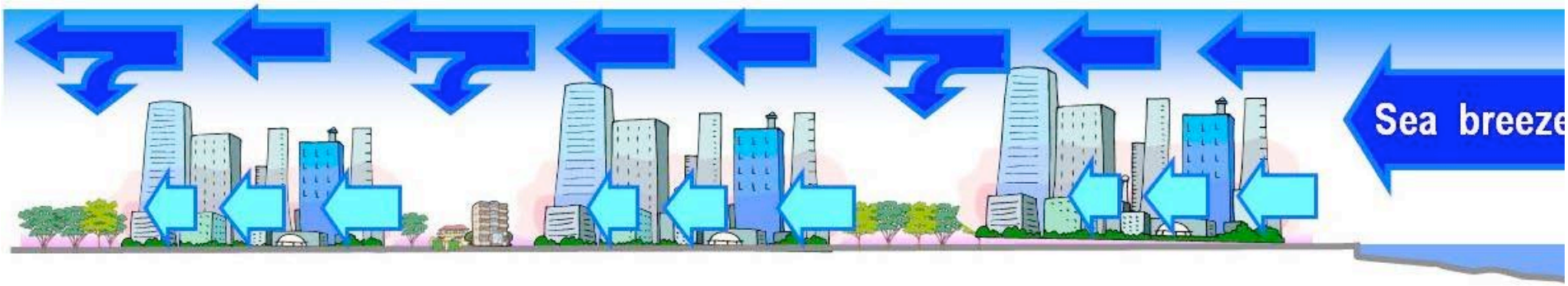
path

(road, route, etc.,)

Ventilation paths in Germany

Comparison of ventilation paths between Japan and Germany

The Japanese ventilation path (*Kaze-no-michi*) where a “thick” sea breeze is led into an urban area is three-dimensional.



The German ventilation path where a “thin” mountain and valley breeze is led into an urban area is two-dimensional.

“Tokyo Wall”


Tokyo Station
Imperial Palace
Group of Skyscrapers
Tokyo Bay

追跡 ヒートアイランド現

湾岸 高層ビルが 東京を「熱地 獄」にする！

巨大な風風が海風さえぎり 将来は最悪4℃上昇も

分かる。でも、超高層ビルまでこんなに密集させるとは、やはり習性か――などと戯言をつぶやいていたら、意外な〝疑惑〟が浮上した。うだるようなこの暑さと、あのビル群には深い関係があるというのだ。

「うちの常連のお客さんがおっしゃるんですよ。『このあのたくさんのビルができてからです」

ある飲食店の女性経営者はそう教えてくれた。

店のドアを開けて目を彼方にやるが、そこに青空はない。あるのは延々と連なる巨大なついたてのように海風を遮断している汐留シオサイトのビル群＝本社ヘリから

尾島研究室がコンピューターで行ったシミュレーションの結果をもとに本誌が作成

海風～ビル通せんぼ

汐留再開発で1～2度暑く

東京都港区の海沿いにある再開発地区「汐留シオサイト」の高層ビル群が、海からの涼しい風を遮り、内陸の都市部が高温化するヒートアイランド現象を助長している可能性が高いことが、2大学などの研究でわかった。ビル群の背後になる虎ノ門や新橋一帯では風が弱まり、夏の最高気温が他の臨海部に比べ1～2度上昇していた。国土交通省も、ヒートアイランド現象との関係に注目、都市計画で風の流れを踏まえる必要性を重視し始めている。

汐留シオサイトはJR新橋駅と浜松町駅の東側に広がる約31㌶。南北約1・2㌔、東西約0・3㌔に14棟の高層ビルが立ち、海側から巨大なついたてのように見える。

早稲田大学理工学部の尾島俊雄教授（建築学）の研究室が、東京湾からの海風の流れがどう変わるかを調べた結果、風がビルの壁で遮断されて弱まり、弱風域は汐留地区の後方1・2㌔以上に及んだ。新橋・虎ノ門地区の風速は再開発前に比べて半減していた。

また、都立大学大学院の三上岳彦教授（気候学）の研究室と都環境科学研究所の調査では、虎ノ門・新橋など港区北部で、シオサイトにビルが建った後の02年7月20日～8月31日の最高気

発地区、汐留シオサイト」、JR山手線新橋駅の東側に広がる約31㌶の土地に、高さ100～200㍍級の超高層オフィスビルや高級マンションが林立している。

日本テレビ、電通、富士通、松下電工など名だたる企業が本拠を構え、劇場やお洒落なレストランが集まる「カレッタ汐留」は若者で連日にぎわう。2年前にその姿を現すと同時に、東京の新名所となったのは周知の通りだ。

だが、未来都市そのもののシオサイトを出て、中低層のオフィスビルや居酒屋が建ち並ぶ、東京のサラリーマンにとっては「ふるさ

顕著な〝変化〟を訴える声にいくつもぶつかった。

「風？　うん、確かに変わった。それまでなかったようなヘンな方向から突然、強い風が吹いたりね」（自営業の男性）

こうした声は、何を反映しているのか。

「シオサイトの高層ビル群が海からの涼しい風をさえぎり、都心のヒートアイランド現象を悪化させている可能性がある――」

そんな驚くべき指摘をするのは、早稲田大学理工学部の尾島俊雄教授（建築・都市環境工学）だ。

都心の気温が異常に高くなり、等温線を引くと海に浮かんだ島のように見えるヒートアイランド現象は、エアコン、自動車からの排熱量の増加や樹木、水面の減少が原因とされる。日本全体では過去100年に平均気温が1度上がったが、東京は3度も上昇している。

Outline of the Policy Framework to Reduce UHI Effects (2004)

- Concerned ministries and agencies of Japanese government promote
  - reduction of anthropogenic exhaust heat
  - improvement of urban surfaces
  - improvement of urban structures
  - improvement of lifestyle
- Also stipulates
  - monitoring system of UHI effects should be improved
  - research and development on the assessment technique for implementation of effective measures should be promoted

Goal of this project

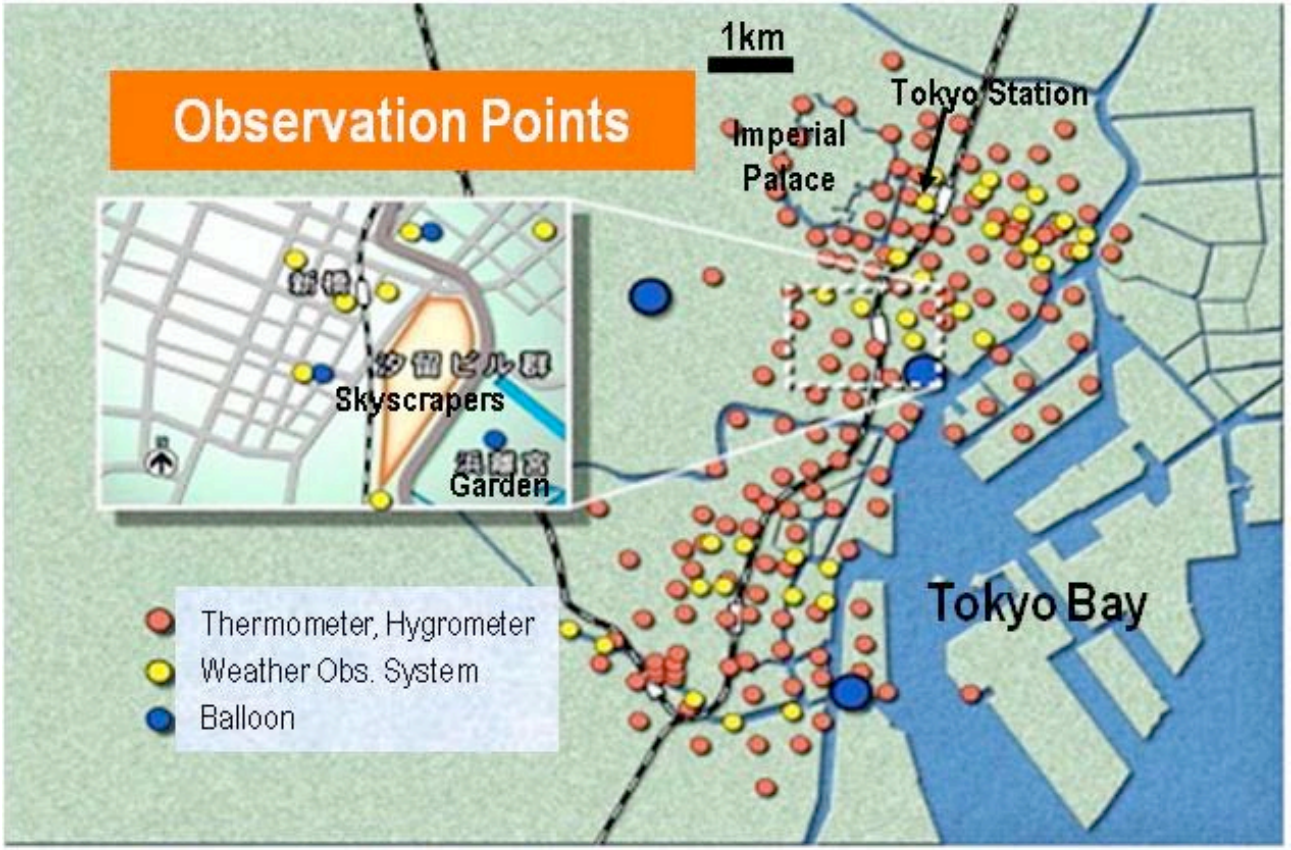
- Which measure will mitigate the UHI more effectively

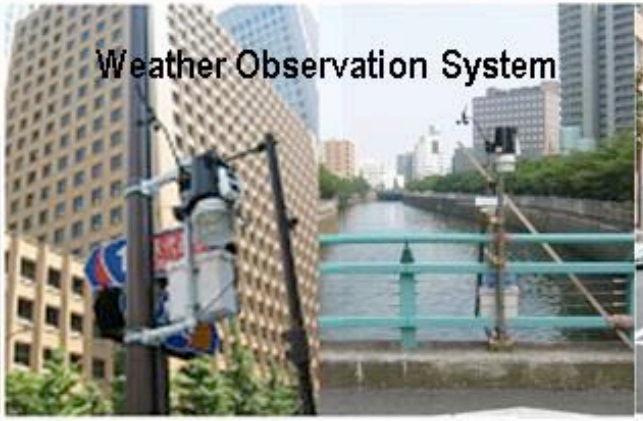
  – Effect of cool sea breeze on coastal urban area had not yet been sufficiently and scientifically investigated for urban planning.
  – We will estimate the effect of measures based on large-scale measurement campaign, wind tunnel test and supercomputer simulation.
  – We will develop PC software for the national and local governments, and companies to devise measures effective in city planning and urban development.

Outline of this national project

- Research Period
  - From FY2004 to FY2006 (for 3 years)
- Budget
  - Approx. 5 million dollars (overall)
- Organization
  - Ministry of Land, Infrastructure, Transport and Tourism (MLIT)
    - National Institute for Land and Infrastructure Management (NILIM)
    - Building Research Institute (BRI)
    - Geographical Survey Institute (GSI)
  - Universities (joint research)
    - Waseda University, Tokyo Metropolitan University, Nippon Institute of Technology

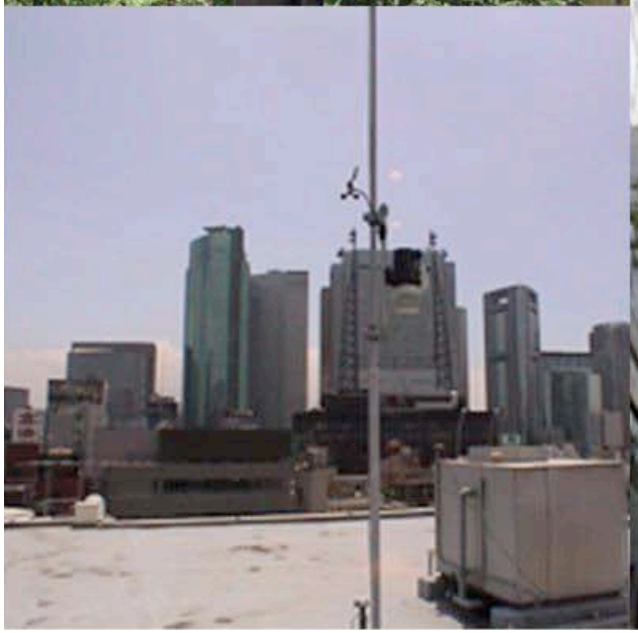
1. Large-scale measurement Campaign





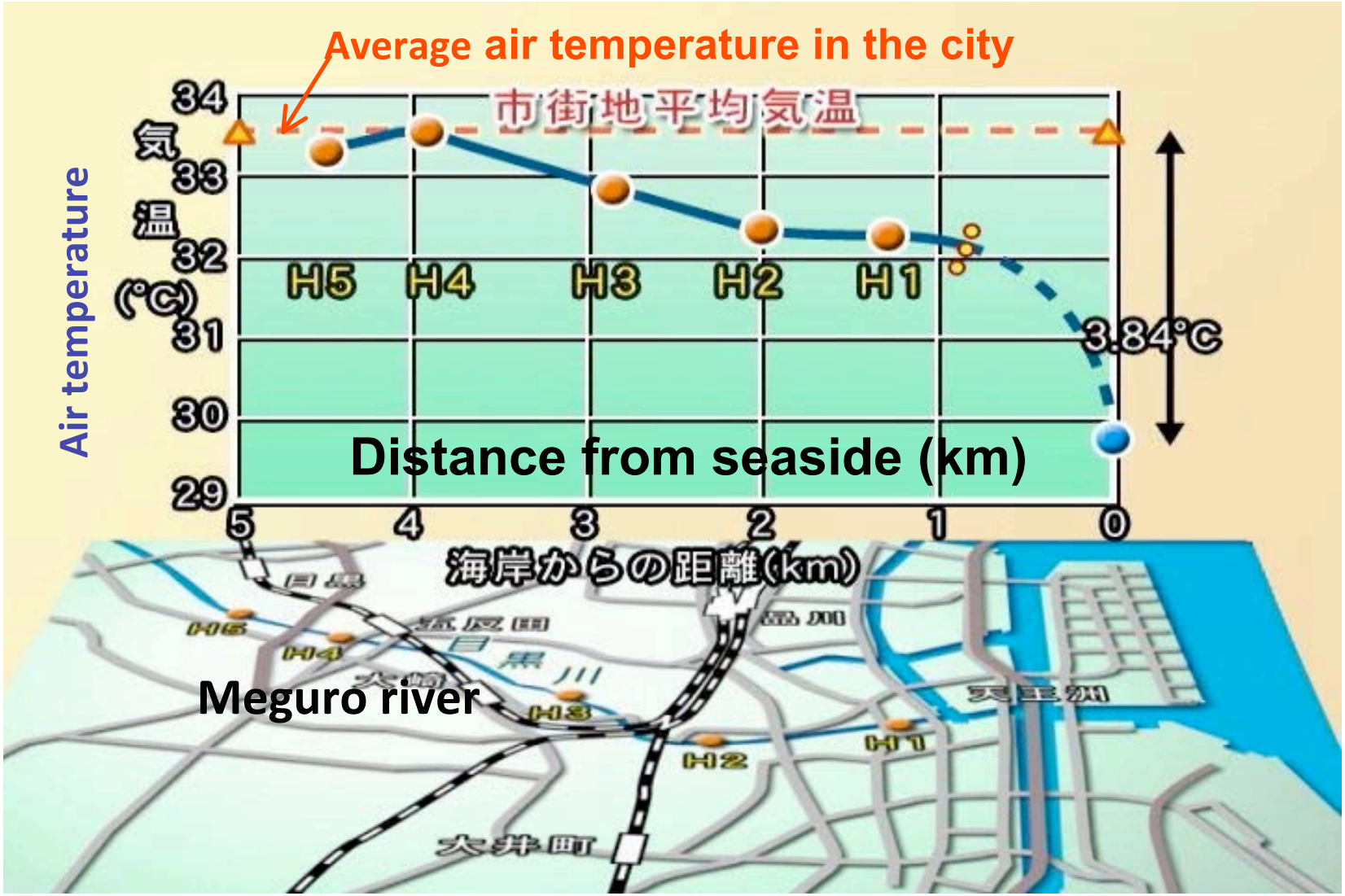
- In summer of 2005
- Observation device had been set in 19(measurement poir



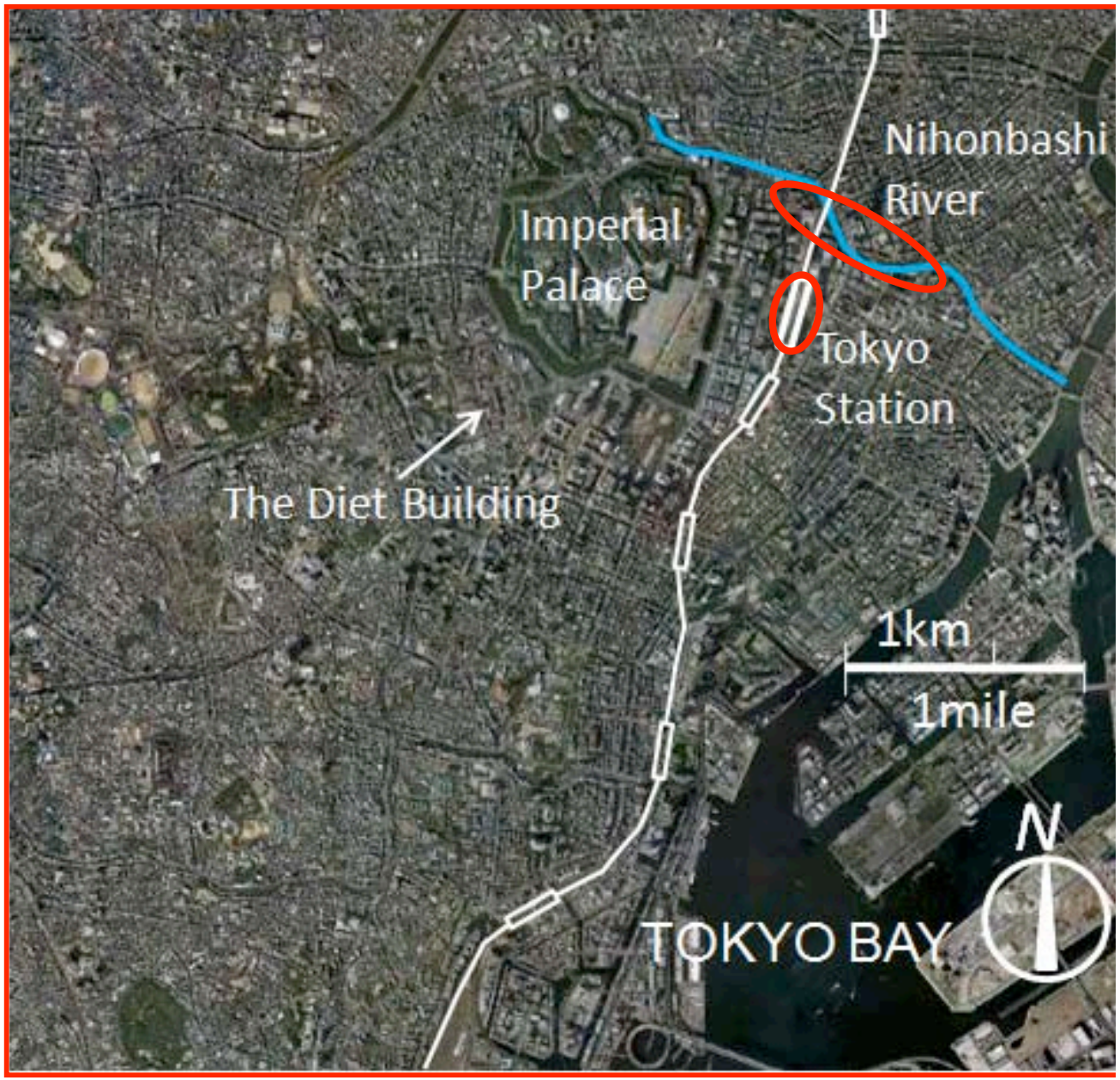
Examples of the meteorological observation results

Examples of the meteorological observation results (Contd.)



3-dimensional utilization of sea breeze

2. Case study on Creation of “Kaze-no-mich

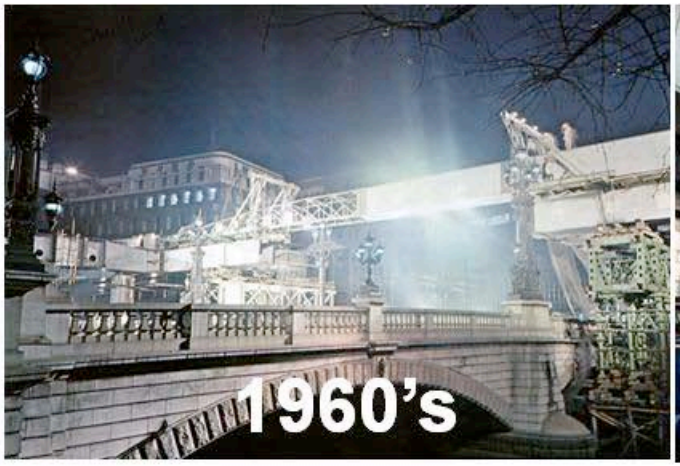


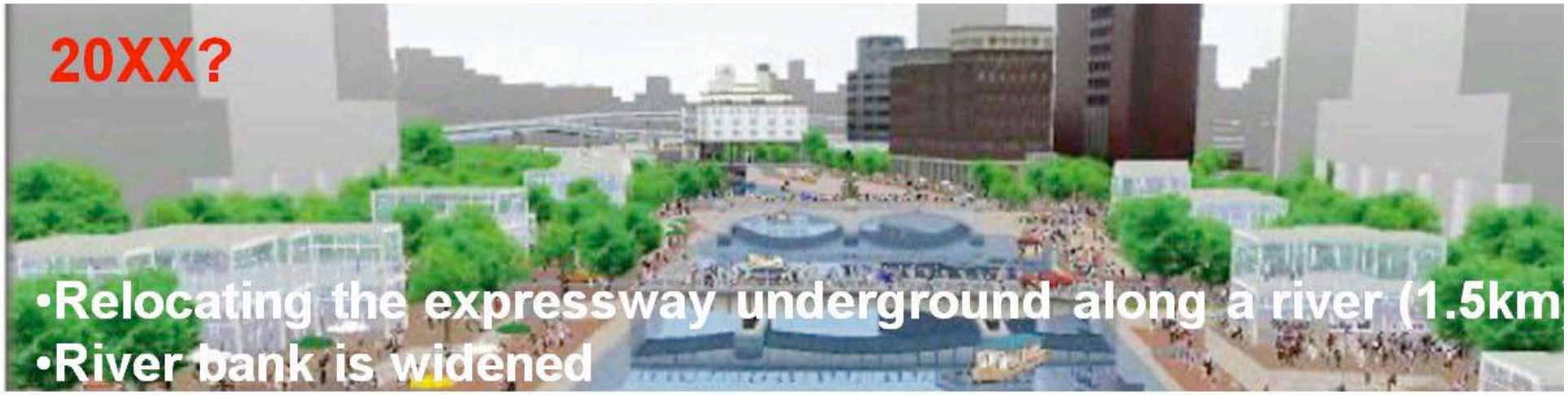
Redevelopment of Tokyo Station

(To be completed in 2013）

Source: http://www.jreast.co.jp/press/2004_1/20040907.pdf

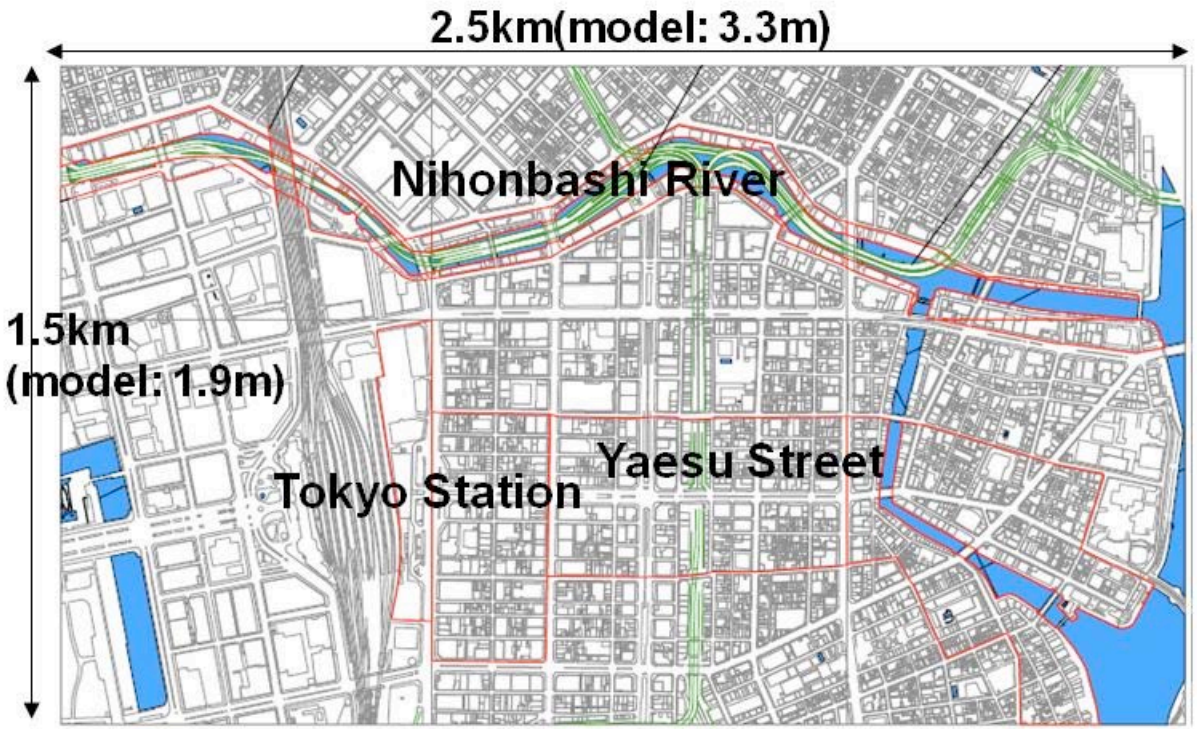
Redevelopment plan along Nihonbashi Rive

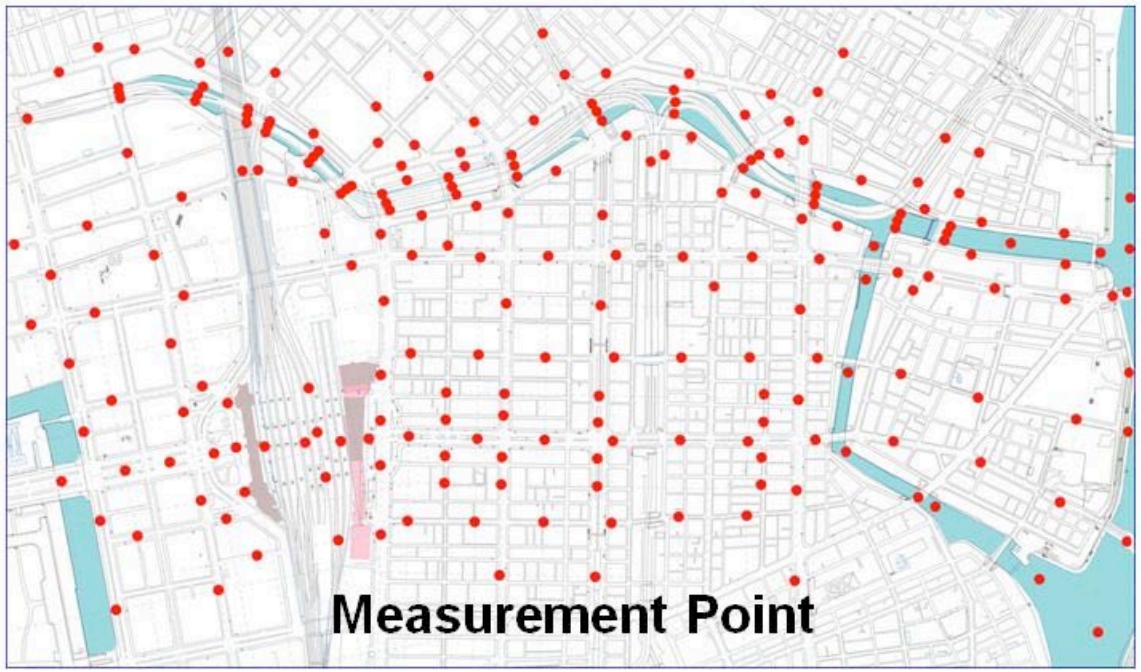




•Riverside landscape is restored

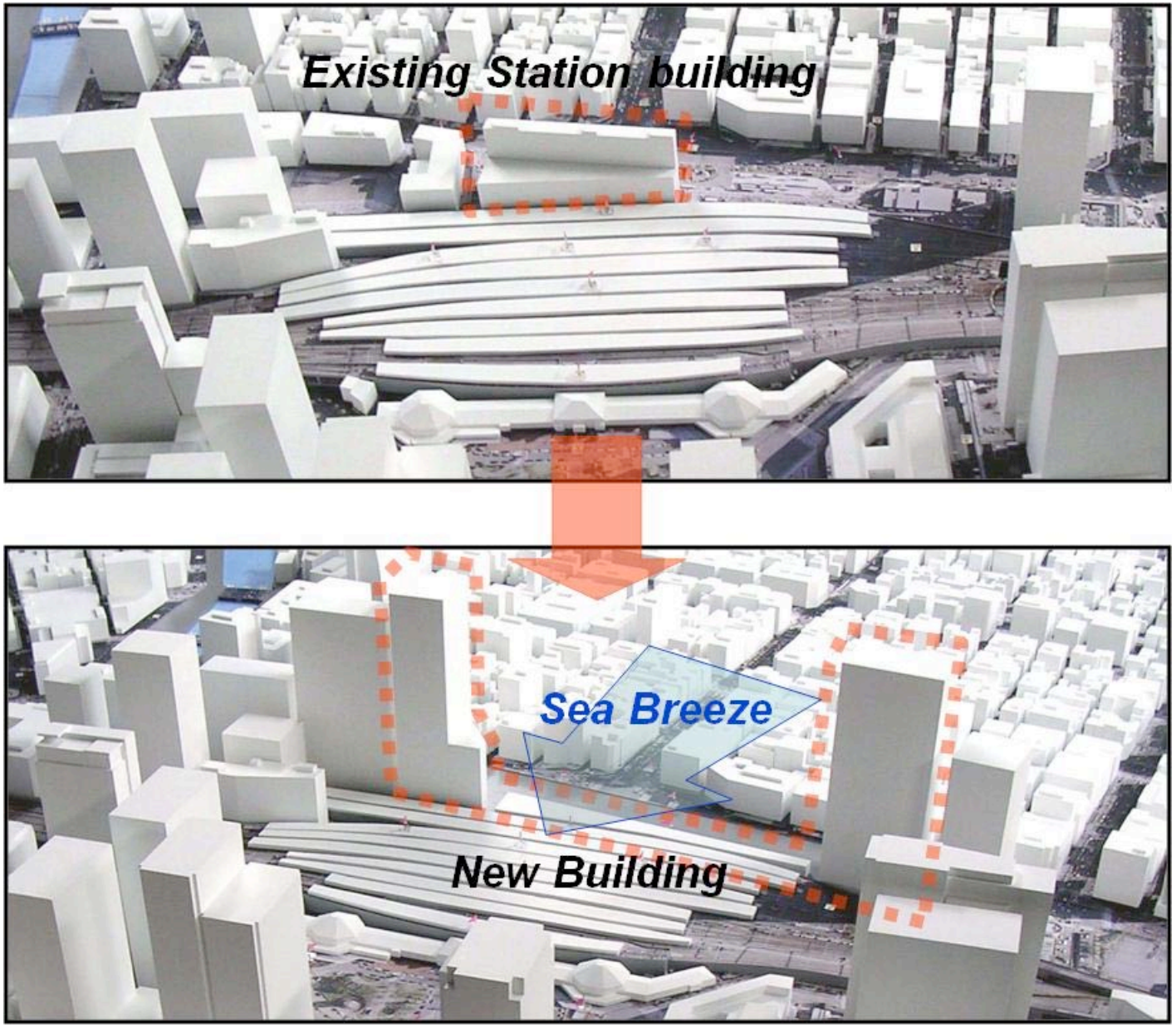
Wind tunnel test for case study





Scale of model
1/750 1.9mx3.3m
(1.5kmx2,5km in actual size)
Horizontal measurement points:
229 points
Vertical measurement point
-3,+5,13,27,53,133,267,400,533,667
(-2,4,10,20,40,100,200,400,500,600m in act
size)
Measurement of wind velocity
Thermister anemometer
(0.1 second interval for 30 seconds / 1 po
Visualization:
Laser sheet (Ar), Small flags

Redevelopment of Tokyo Station



Redevelopment plan along Nihonbashi Rive

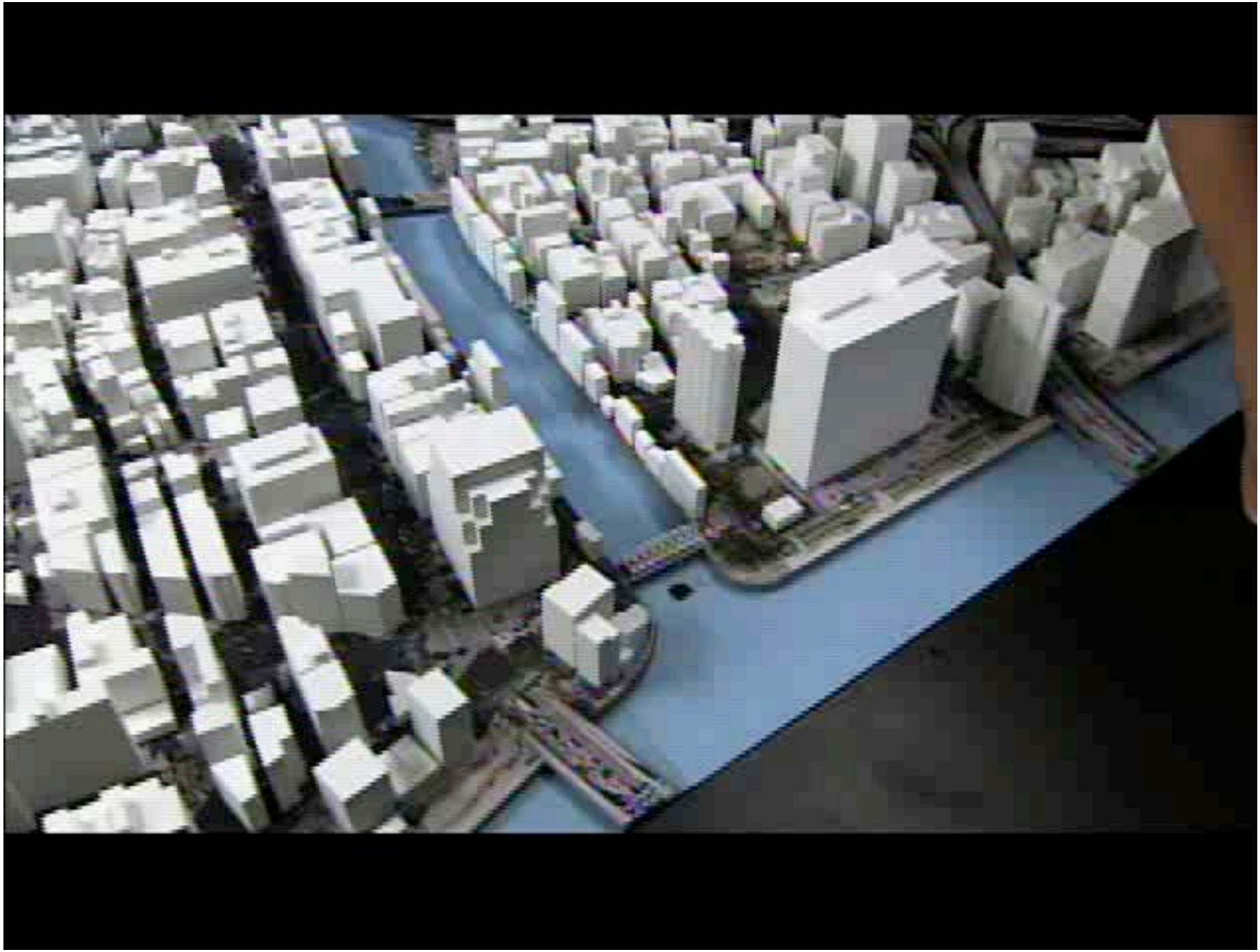
Present

Plan

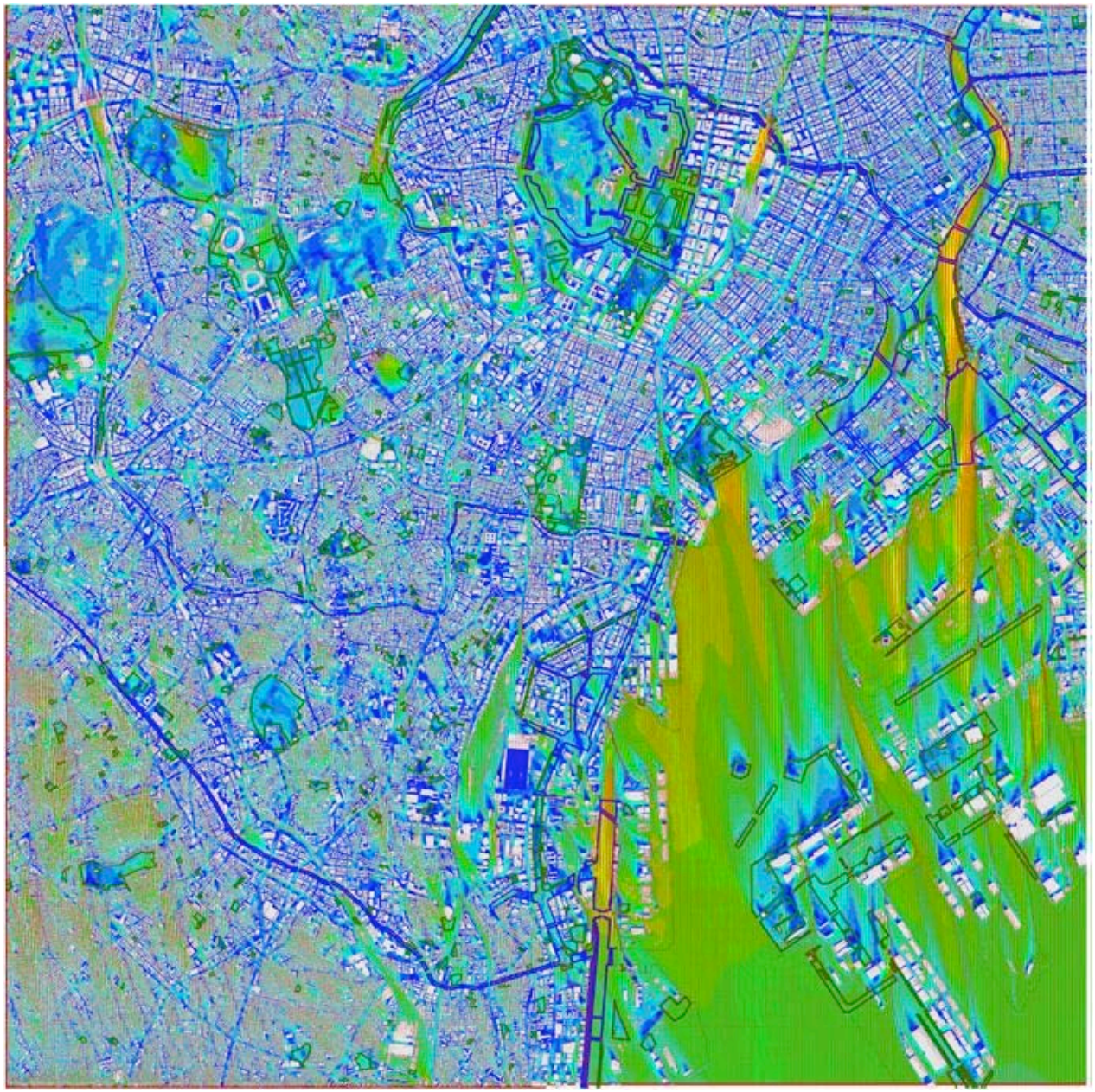
•Relocating the expressway underground along a river

•river bank is widened

•riverside landscape is restored



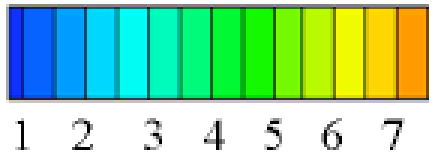
3. CFD Study Using the Earth Simulator (E.S



Simulation result 10kmx10km of central Tokyo and Tokyo bay area

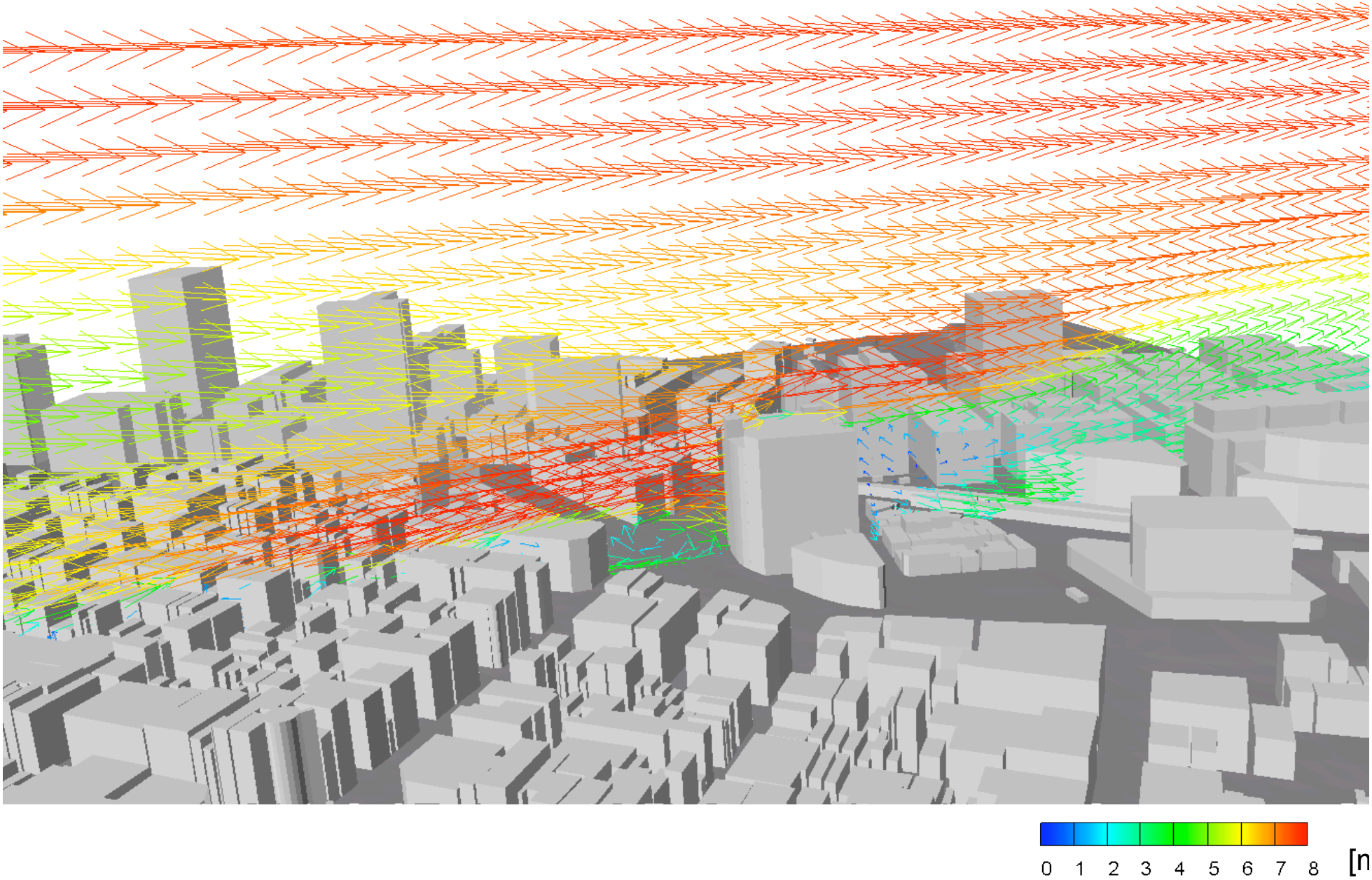
July 31, 2005

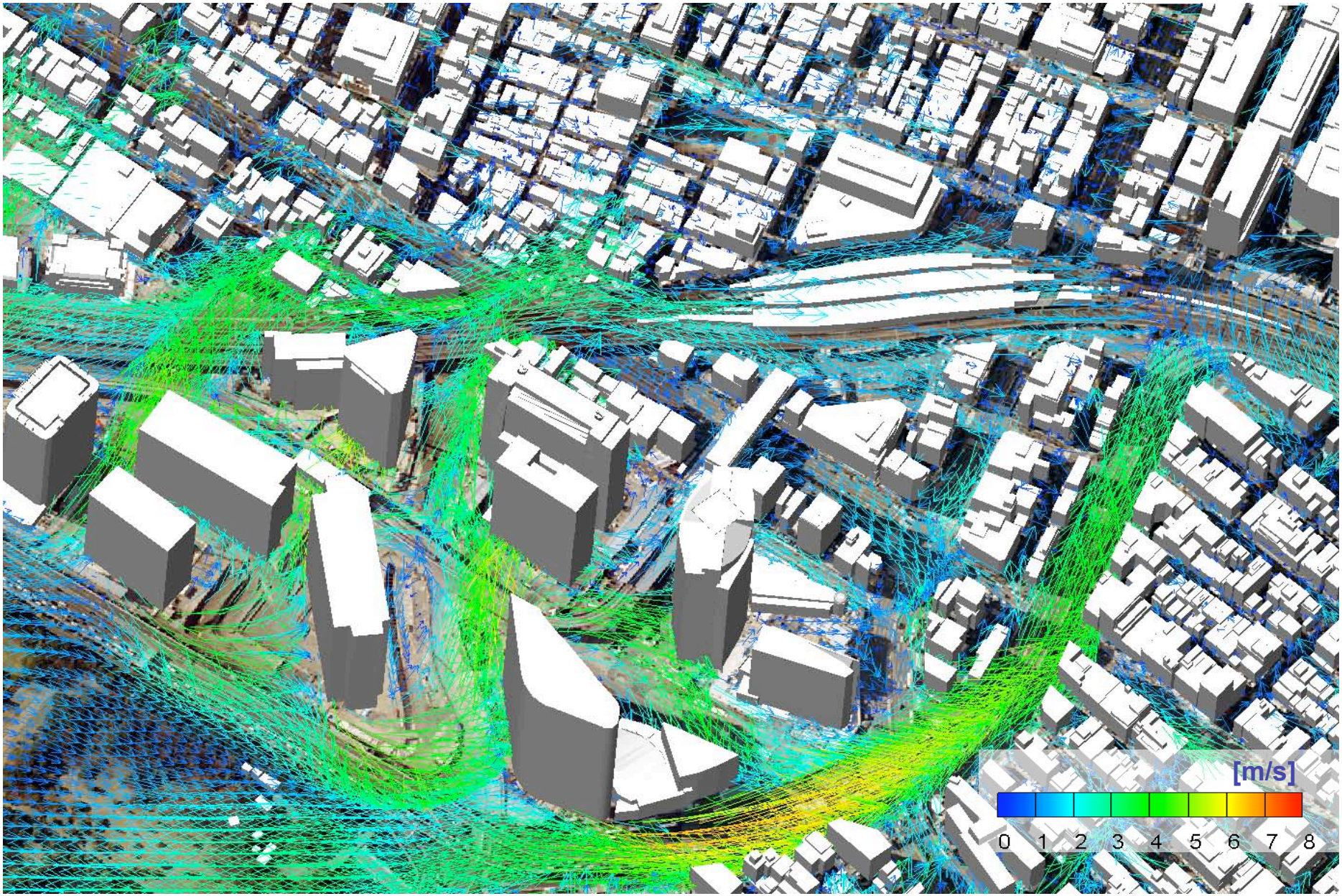
10m above ground level

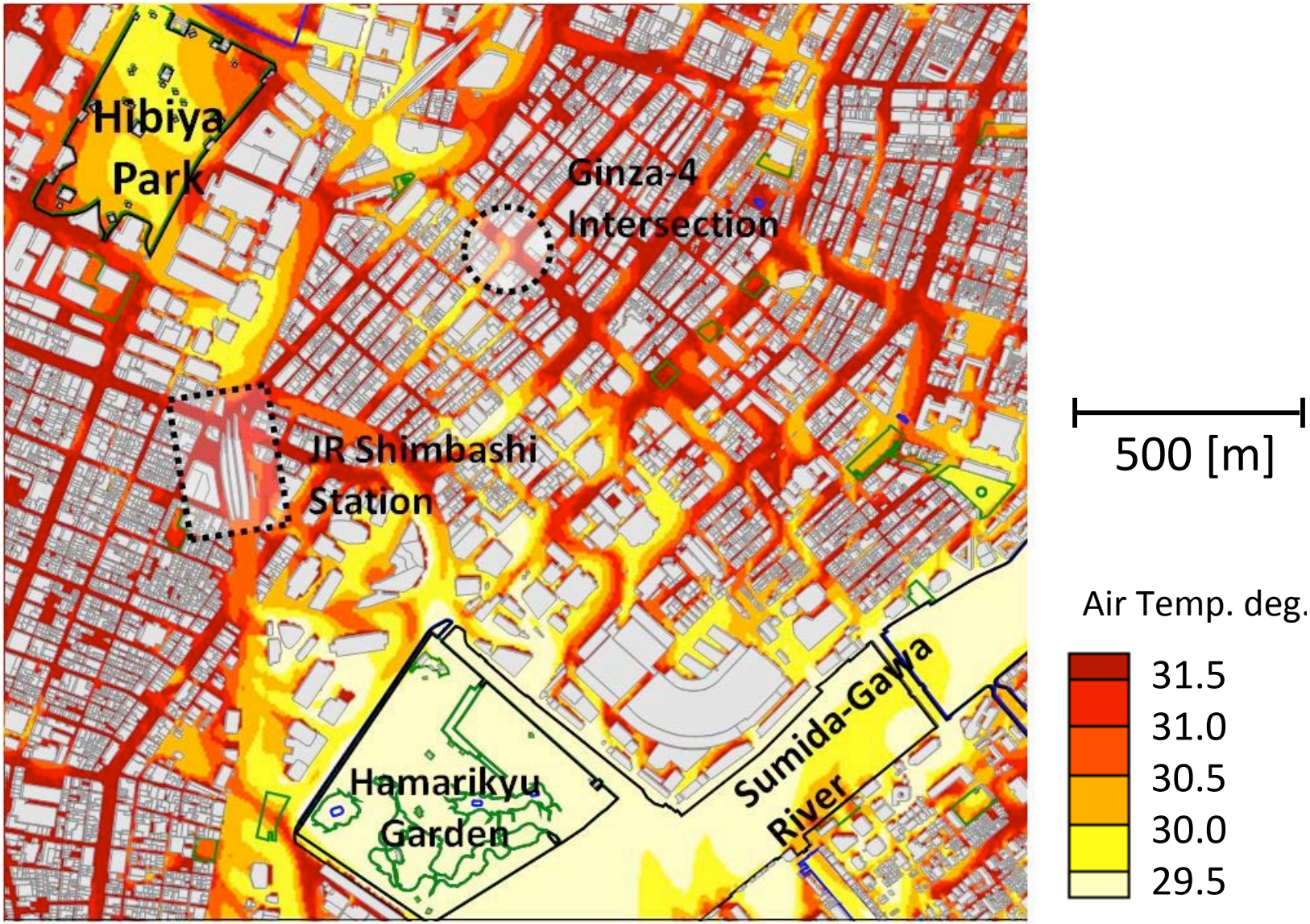


New Environmental Analysis System using the E.S. (Ashie et al. 2007, 2008)

- Incorporated potential temperature and Coriolis force into standard k-ε scheme
- The boundary and initial conditions employed the simulation results of a meso-scale model.
- Terrain, land use and geometry information of buildings and streets was generated from DEM and GIS database of Tokyo.
- Can calculate Temperatures and wind conditions up to 500m height and 33km-square with 5m grid horizontal spacing (approx. 1.6 million buildings).


0 1 2 3 4 5 6 7 8
[n


[m/s]
0 1 2 3 4 5 6 7 8

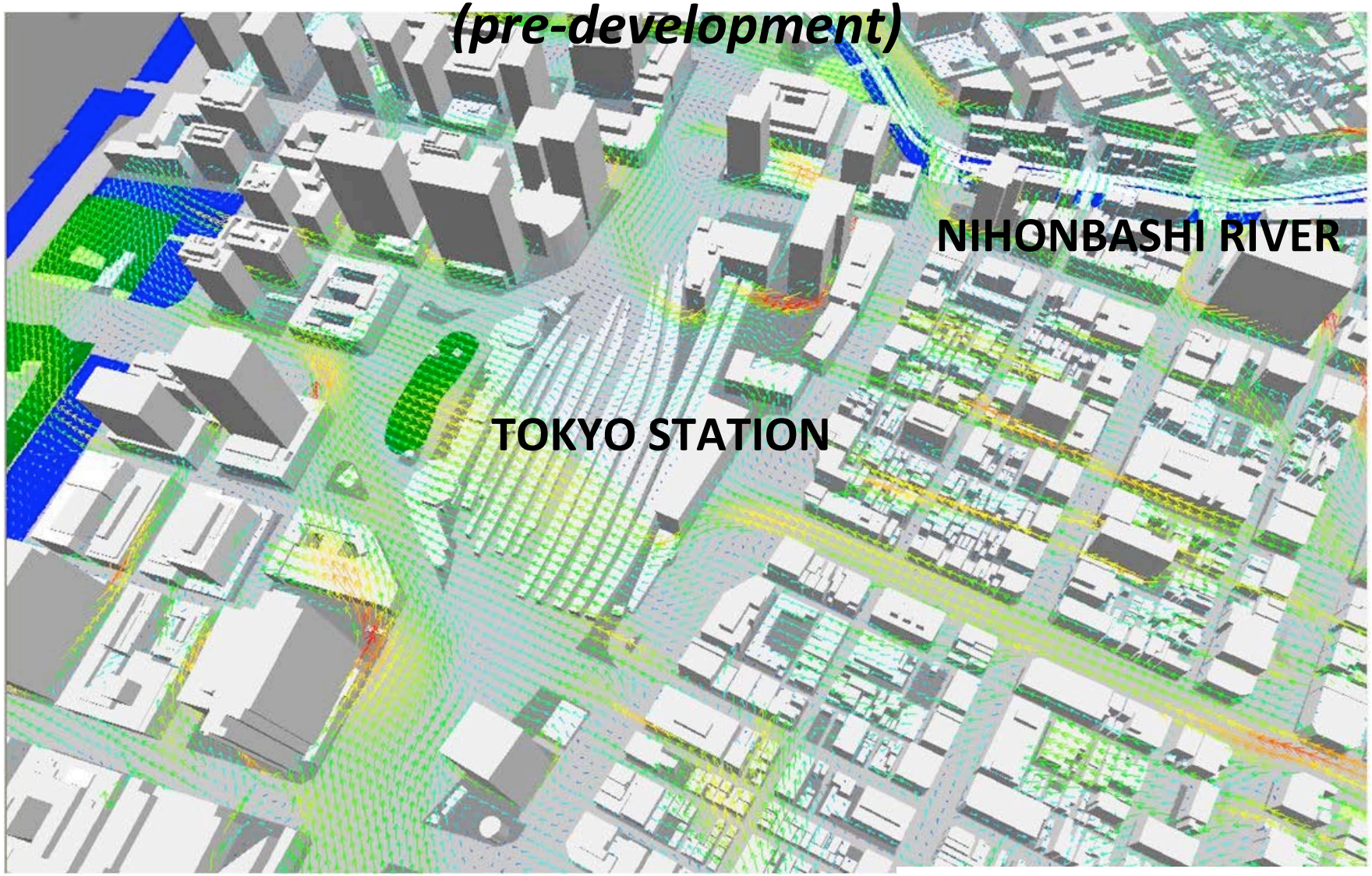


Simulation Result of Air Temperature -July 31, 2005

2m above the ground

CFD simulation result using E.S.

(pre-development)

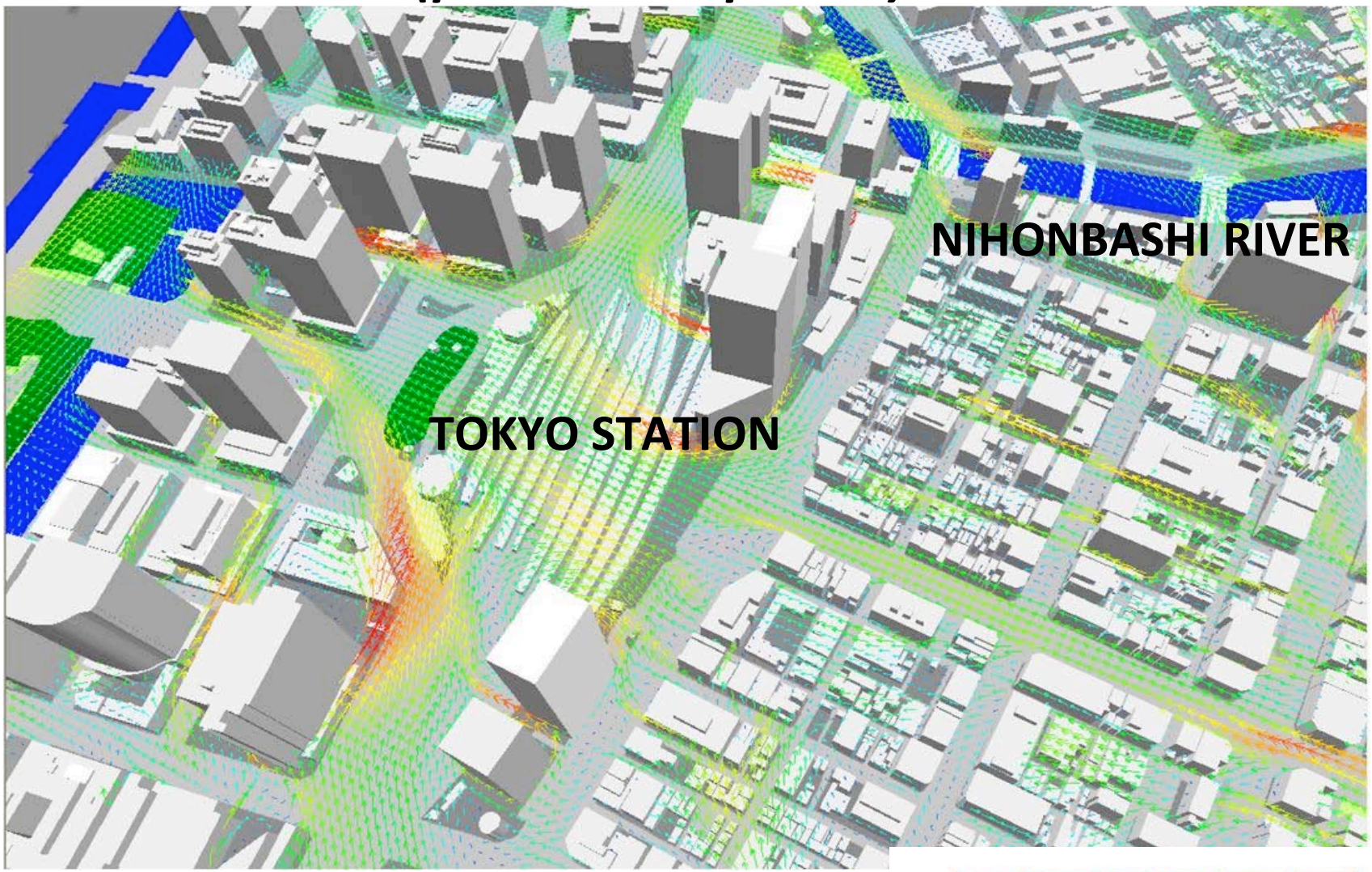


Simulated in 1m resolution, Drawn in 10m resolution

Wind speed 30m above ground level

CFD simulation result using E.S.

(post-development)

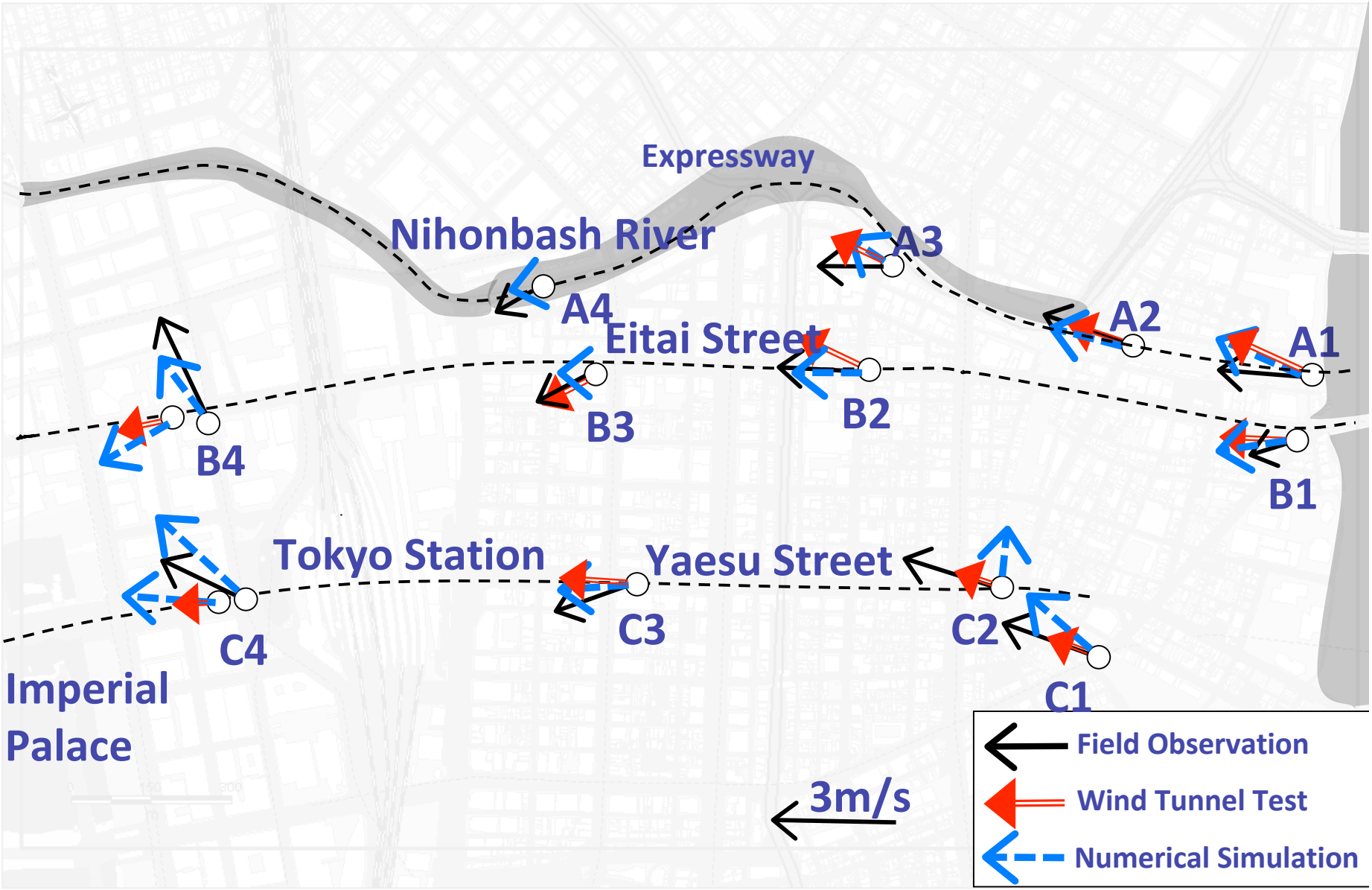


Simulated in 1m resolution, Drawn in 10m resolution

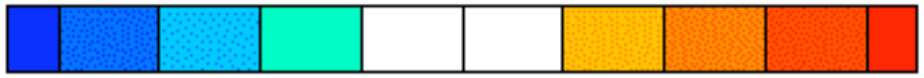
Wind speed 30m above ground level

Comparison of wind speed and direction

(5m above the ground level)



Air Temperature Difference (between pre- and post development)

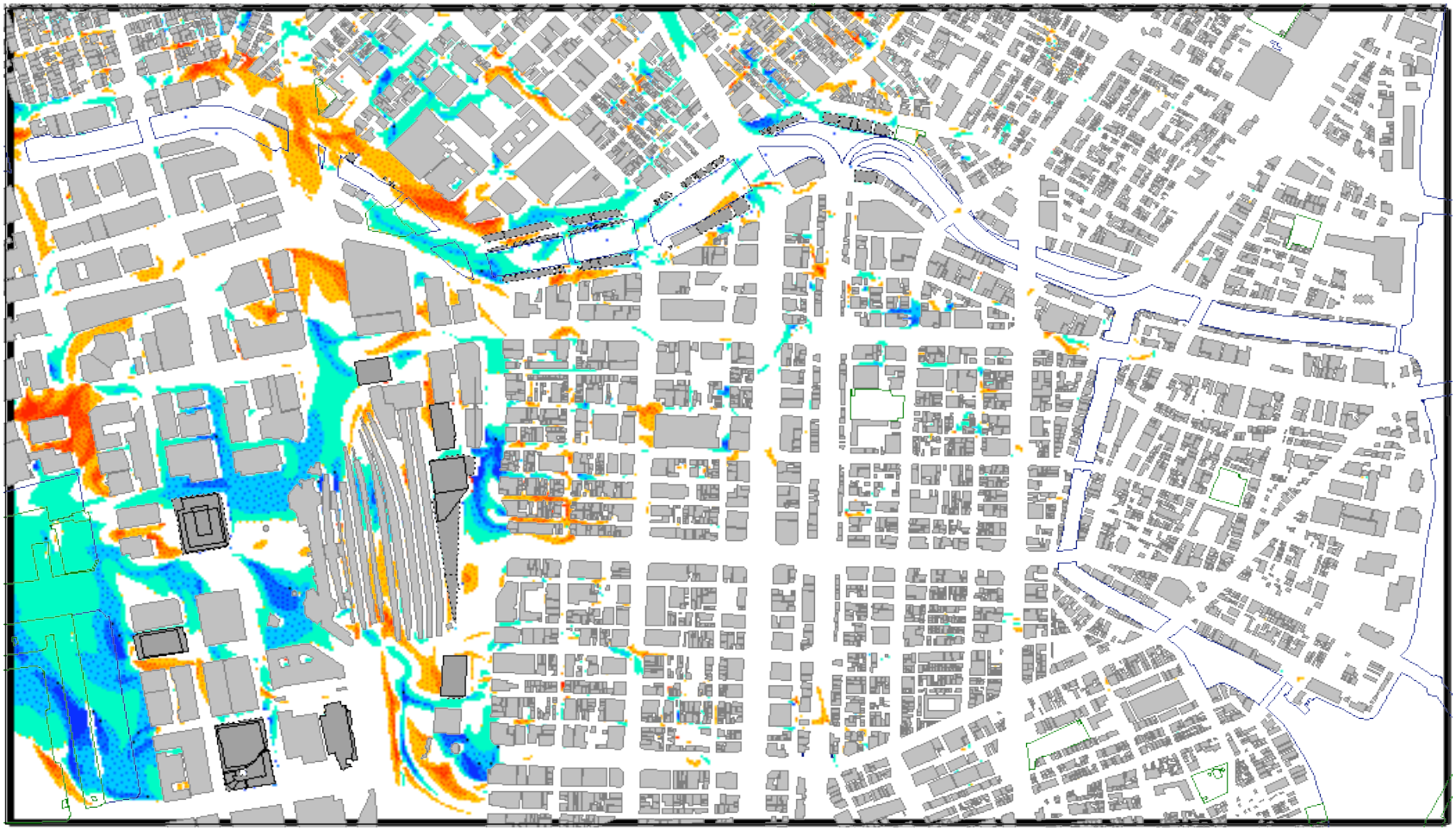


-2 -1.5 -1 -0.5 0 0.5 1 1.5 2 2

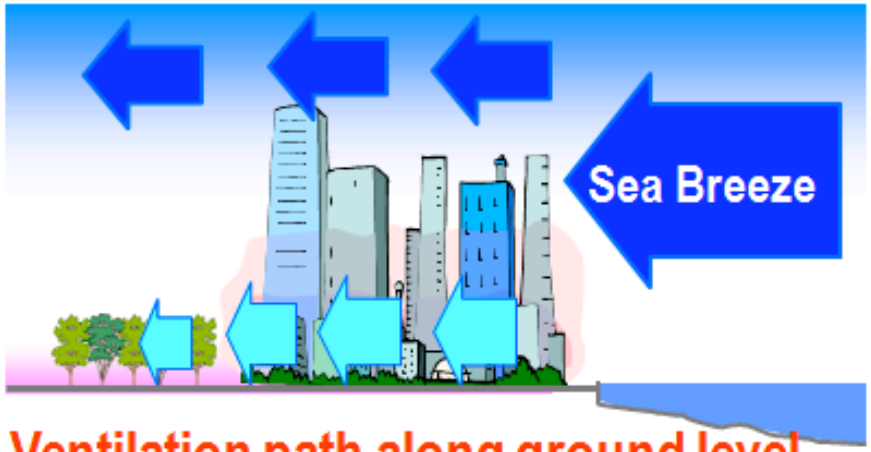
Air Temperature Difference (Degrees Celsius)

2m above the ground level

500m

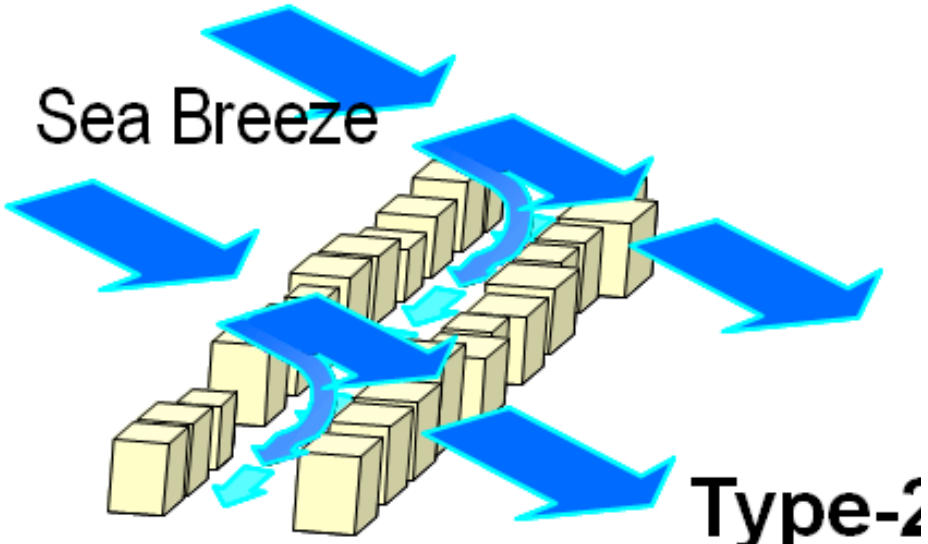


4. For Applying "Kaze-no-michi" in City planning



Ventilation path along ground level

Type-1



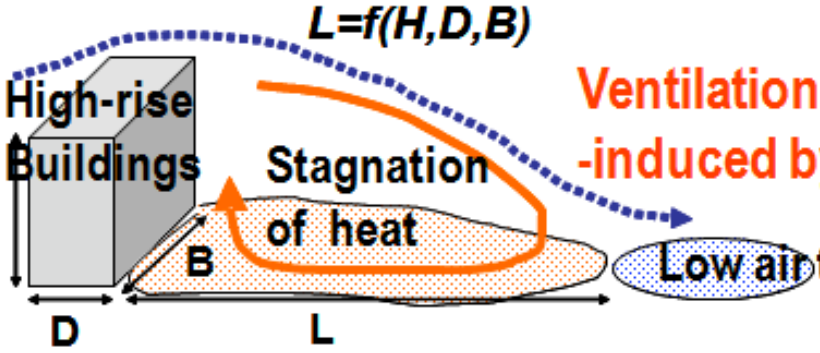
Type-2

Ventilation path
-induced by streets and rivers

Sea Breeze

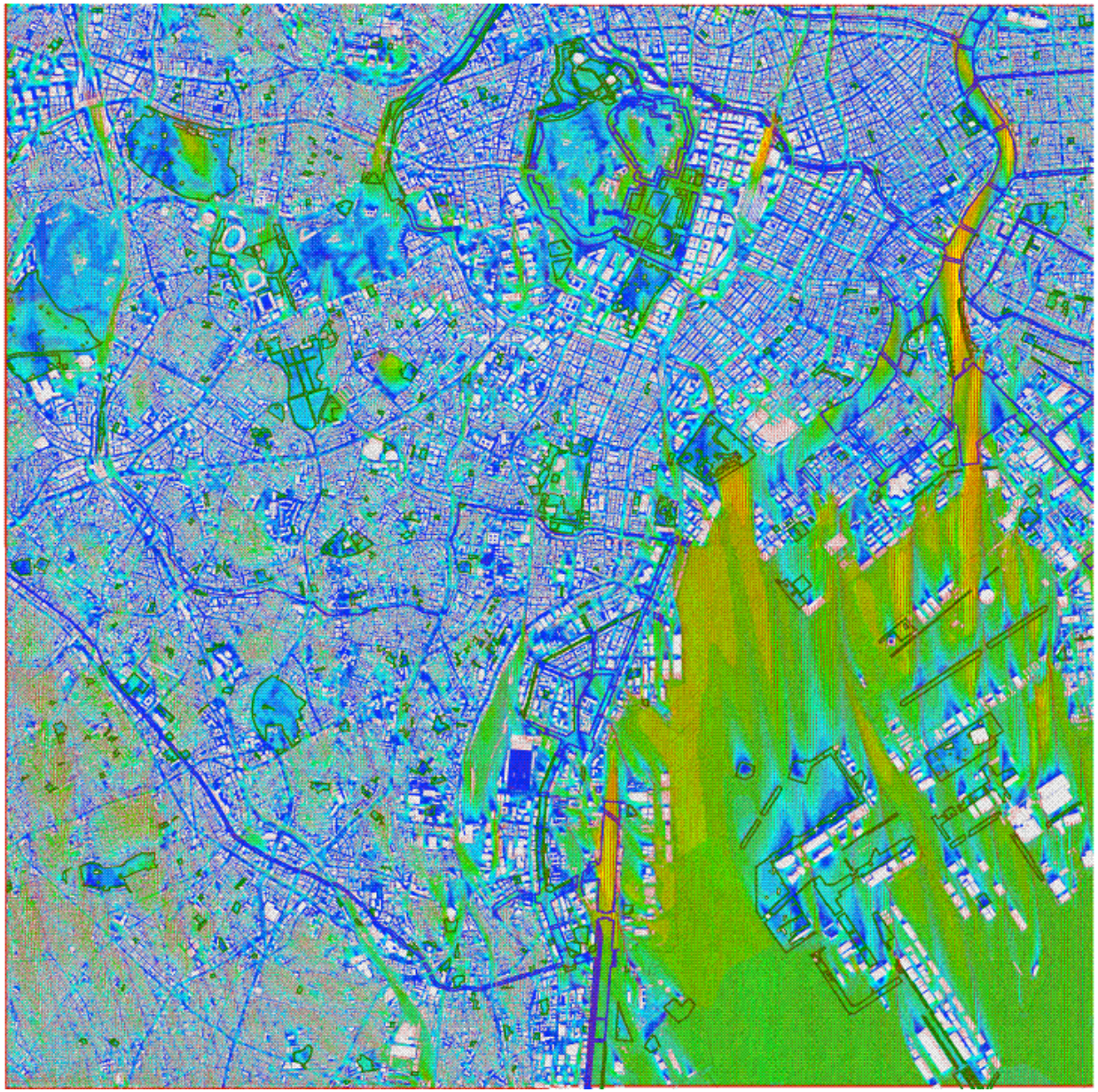
H

Type-3



Ventilation path
-induced by high-rise buildings

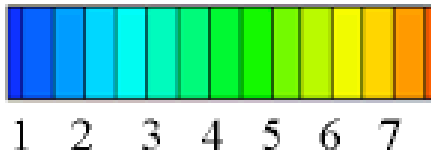
Illustrating of "Kaze-no-michi" with E.S.



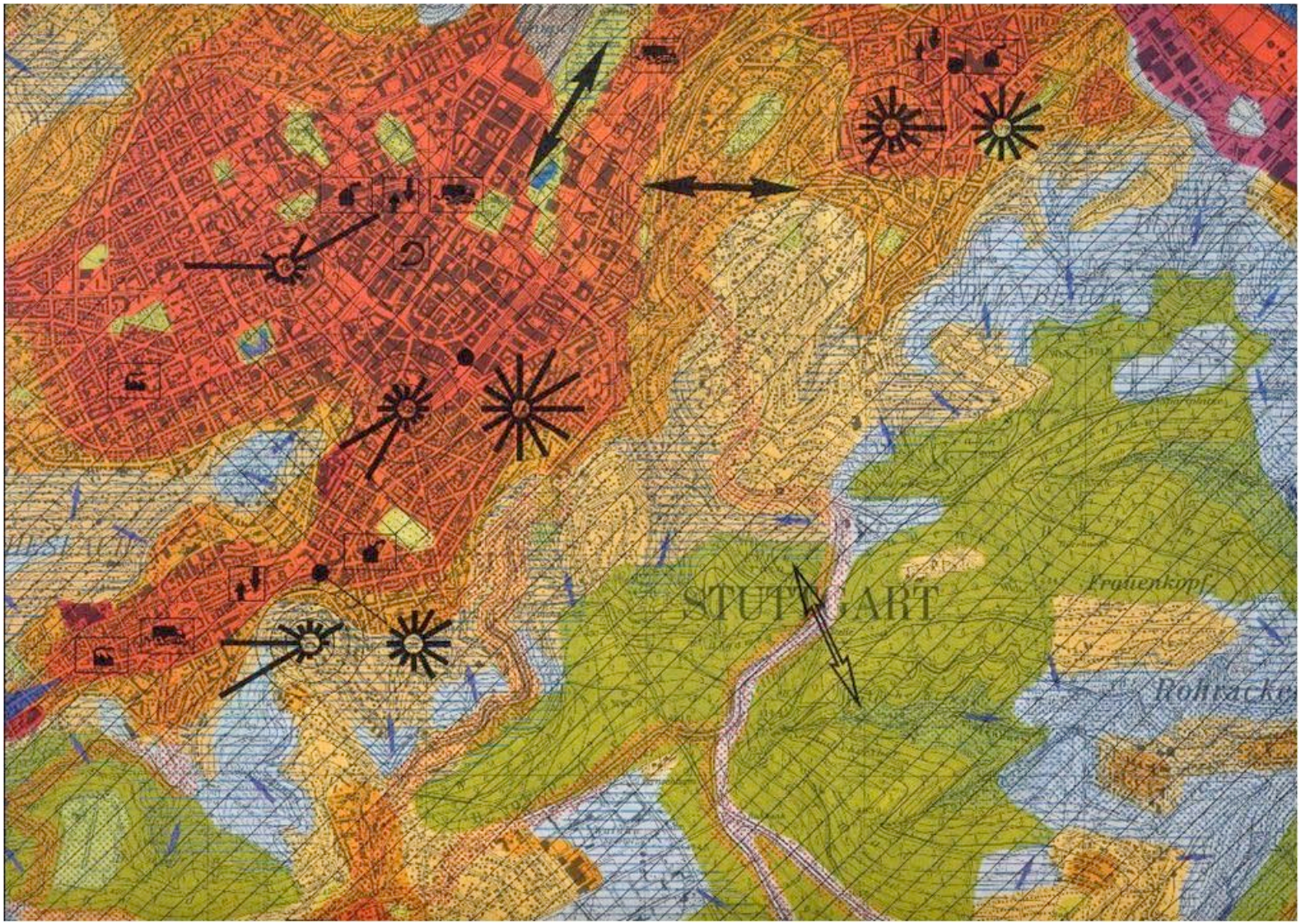
Simulation result 10kmx10km of central Tokyo and Tokyo bay area

July 31, 2005

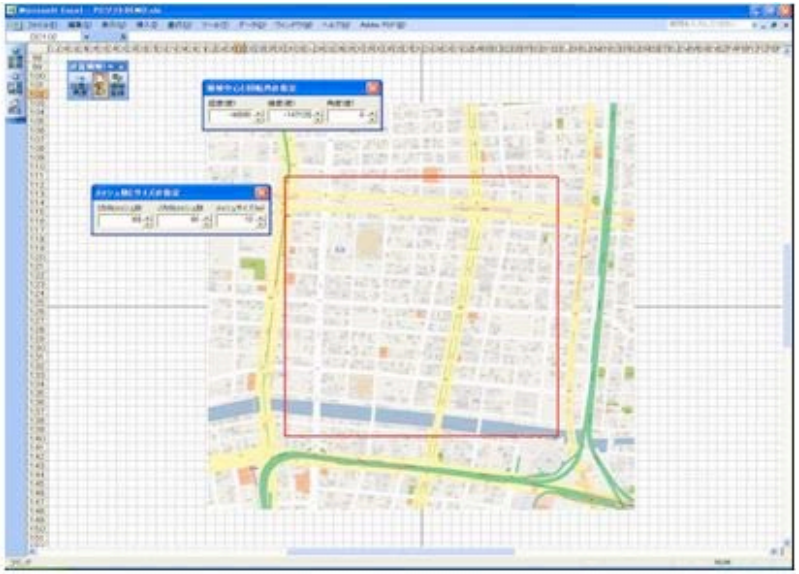
10m above ground level

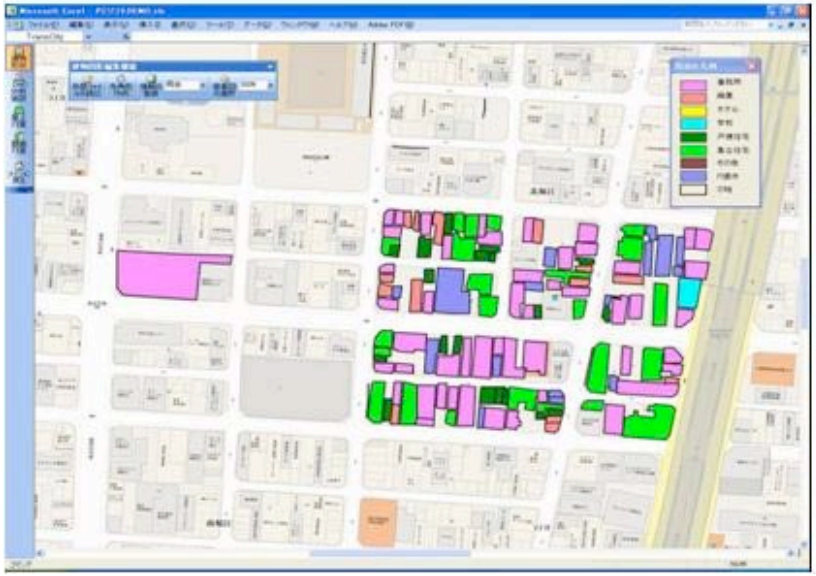


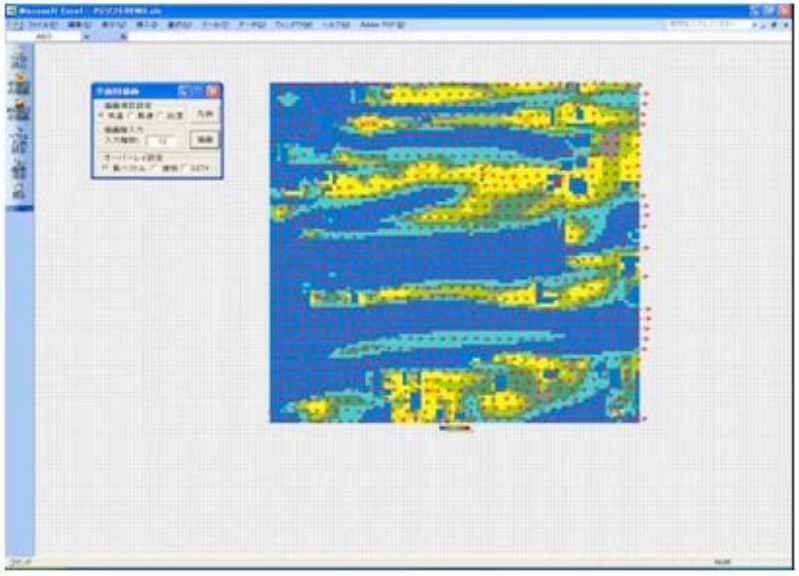
Klimaatlas for German City Planning



Development of PC software

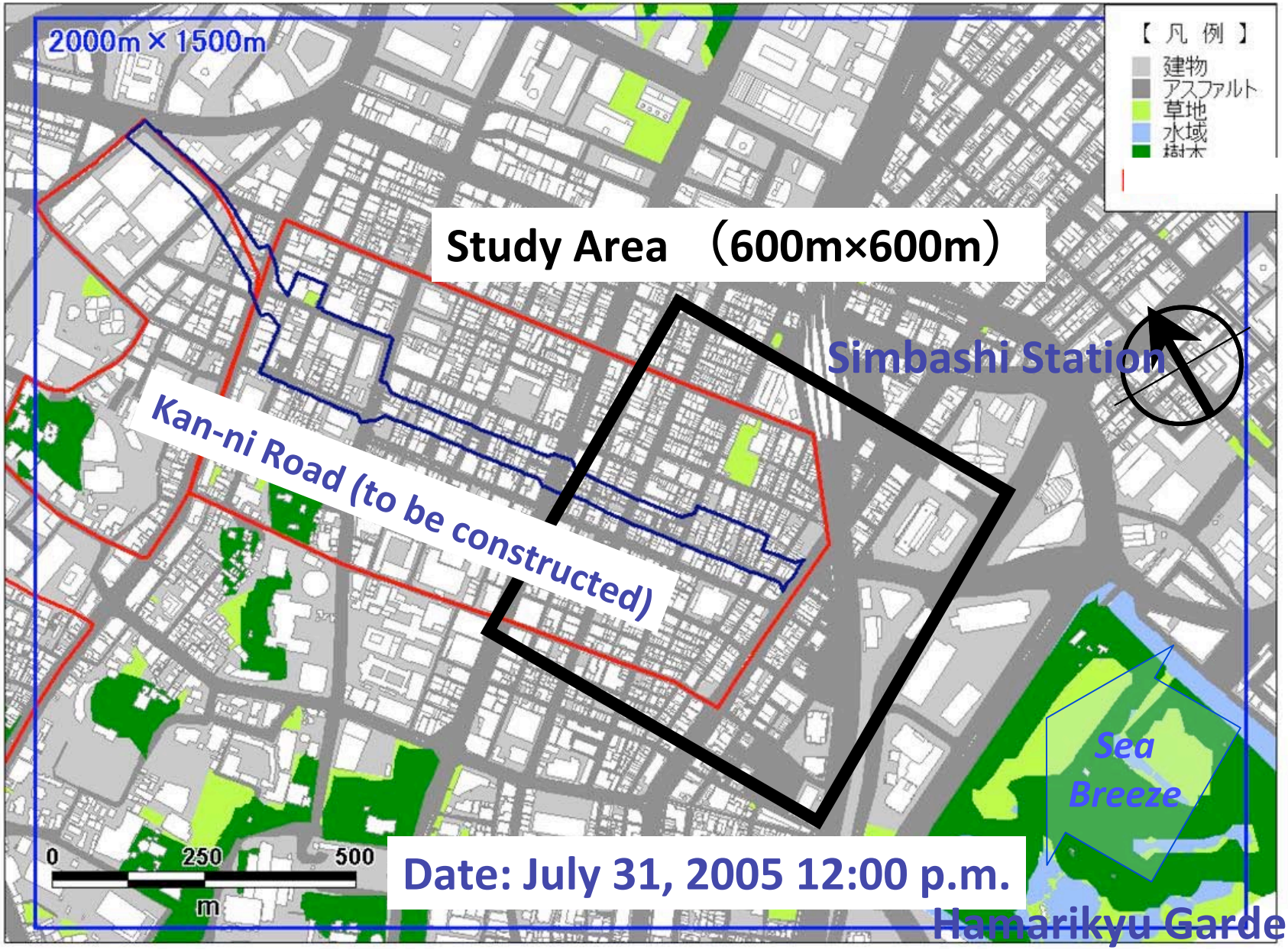




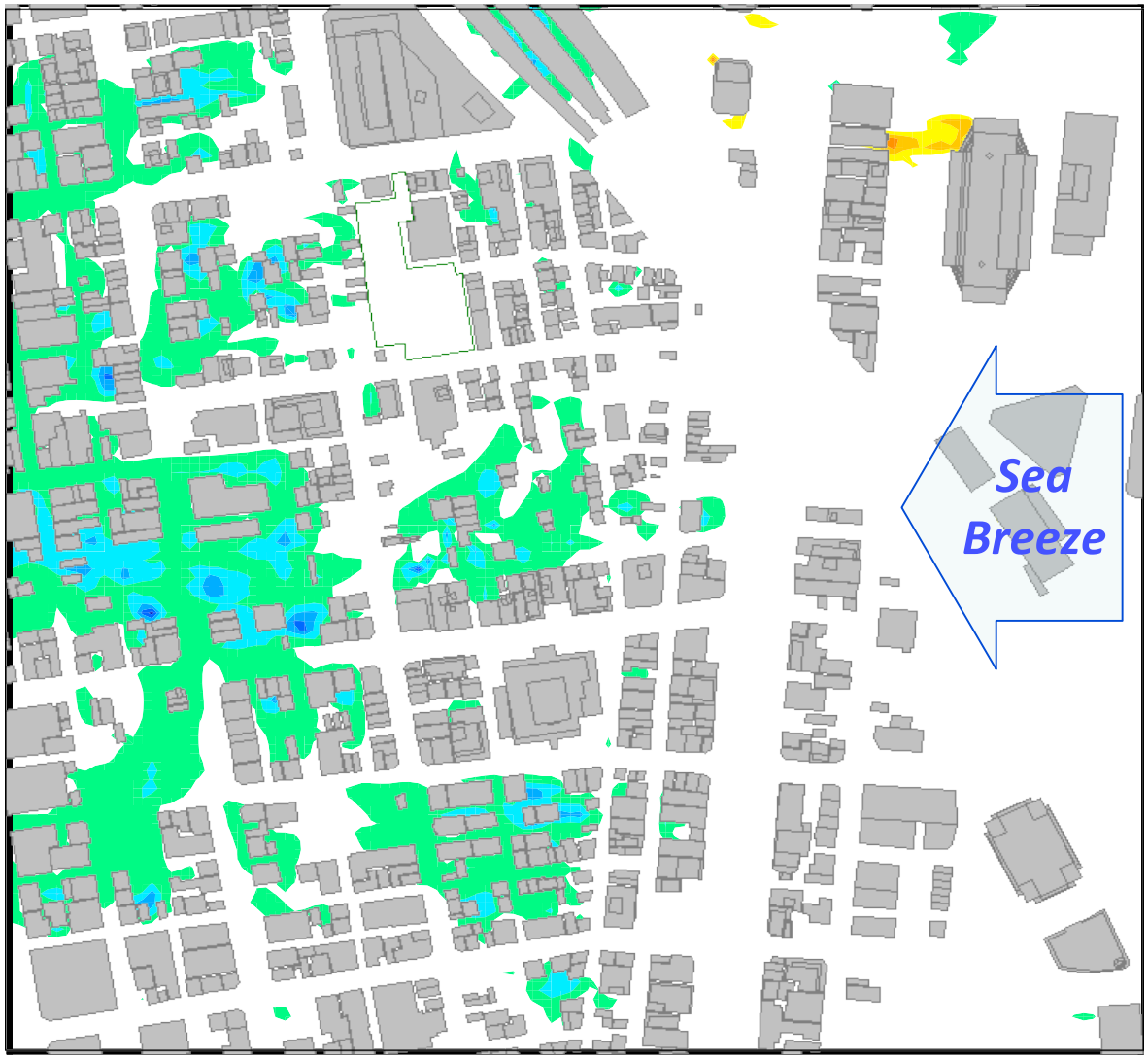


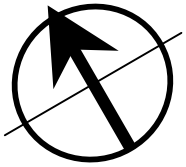
It runs on Excel: not required special software.

Case study area for simulation



Effect of Roof-top greening

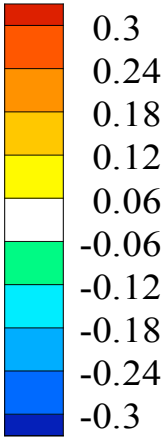




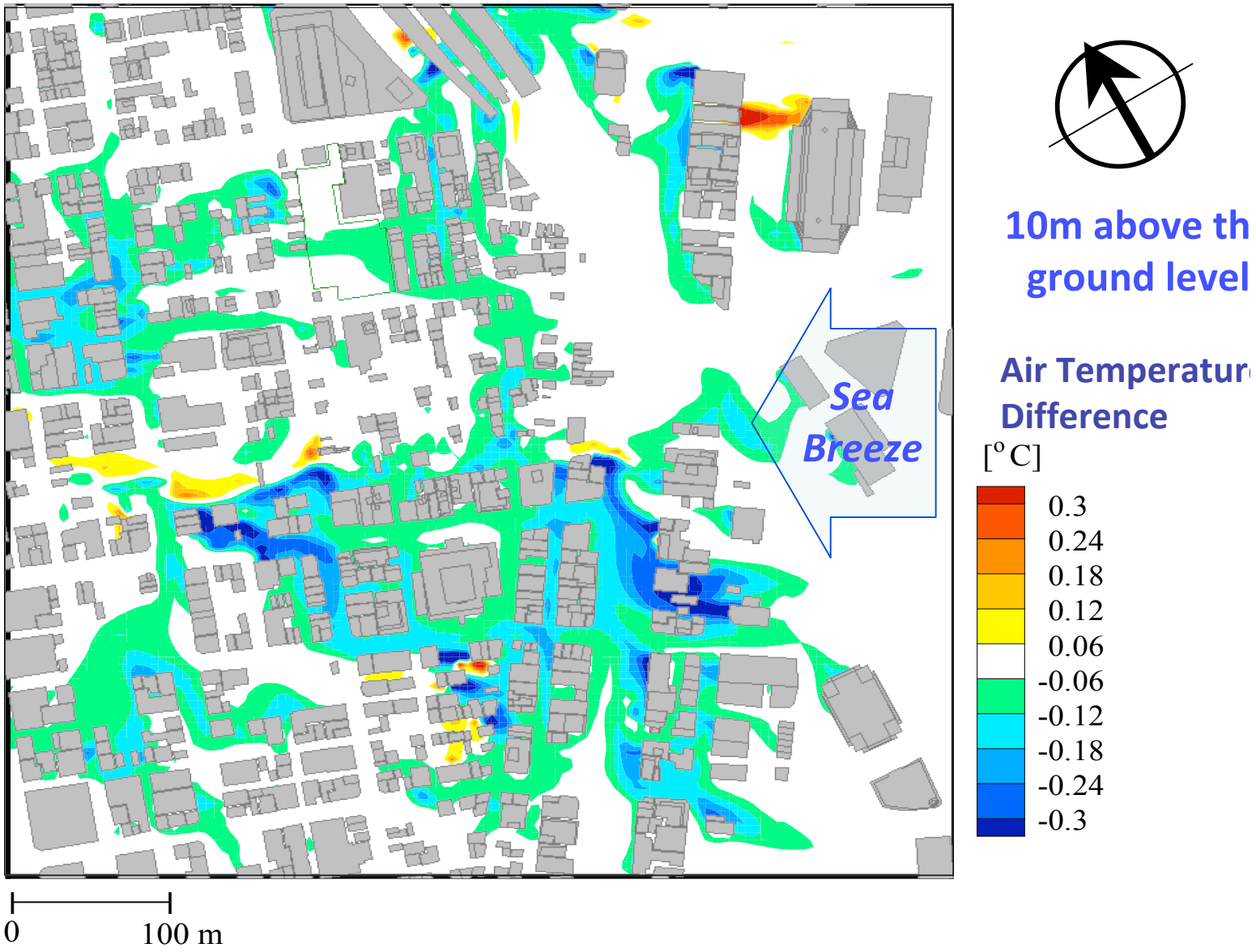
10m above th ground level

Air Temperatur Difference

[°C]

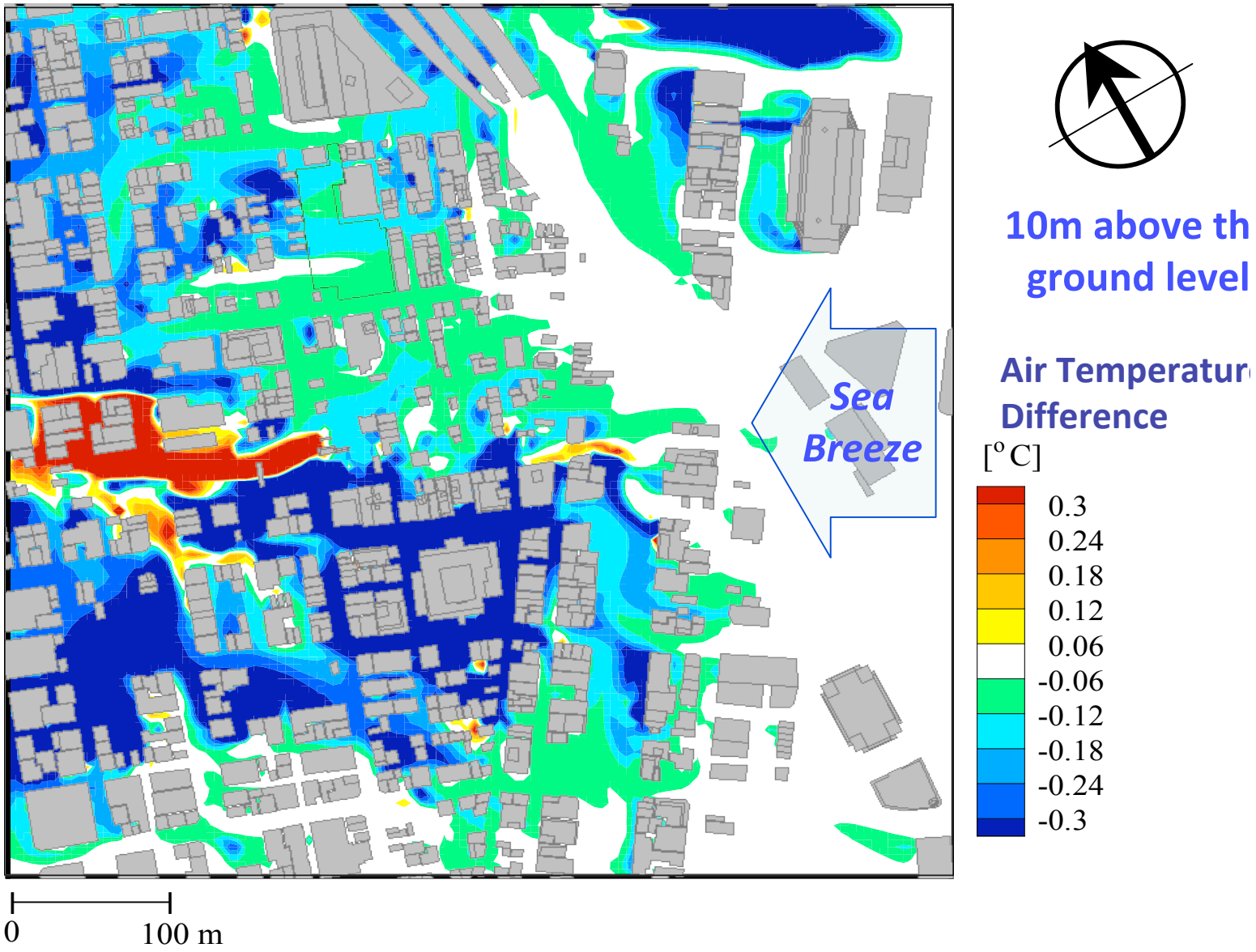


Effect of greening and cool pavement

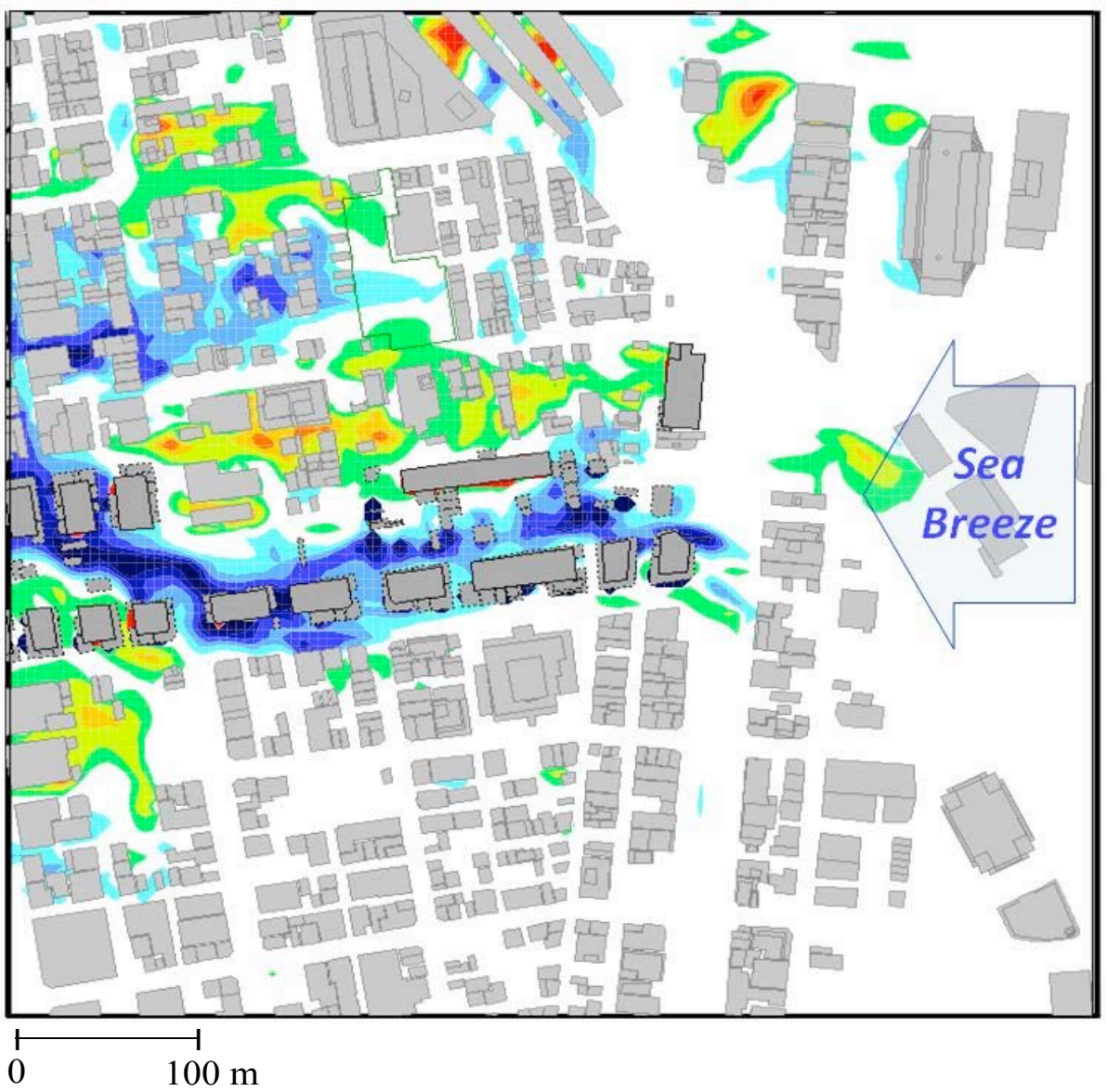


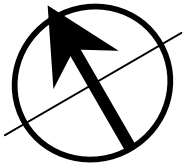
Effect of energy omission

(e.g.. Improving the performance of air conditioner)



Effect of redevelopment with a main road





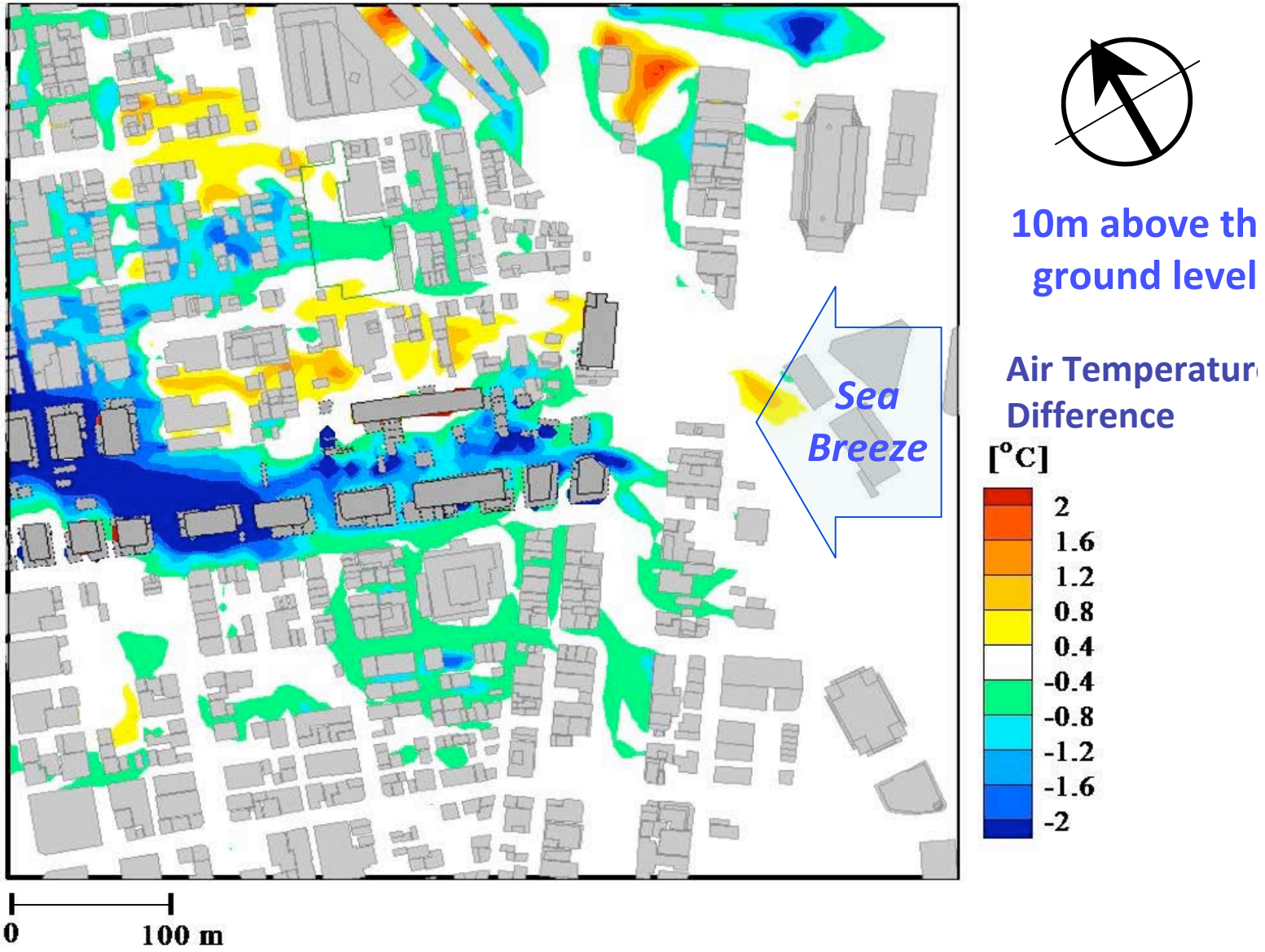
10m above th ground level

Air Temperatur Difference

[°C]

2
1.6
1.2
0.8
0.4
-0.4
-0.8
-1.2
-1.6
-2

Effect of overall measures



Summary

- National research project on ventilation paths is introduced:
  - Large-scale Measurement Campaign
  - Case Study on Creation of "*kaze-no-michi*"
  - CFD Study using the Earth Simulator
  - For Applying "*kaze-no-michi*" in City Planning
- A concept of "*kaze-no-michi*" for city planning is introduced.
- Development of PC software is introduced

(Near) Future Work

- Measures based on policies
  - To organize action menus according to local properties.
    - Such as Urban Environment and Climate Map
  - We will include them in low-carbon city planning guidelines.
- Easy-to-understand effect of measures
  - Sensible (Visible) evaluation, cost benefit analysis, etc.
- User-friendly PC software for assessing the UHI measures
  - To provide this software as a practical evaluation tool to the national and local governments, NPOs for town planning, and private companies.
  - Incorporated with low-carbon efficiency also should be considered

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Thank you for your attention.